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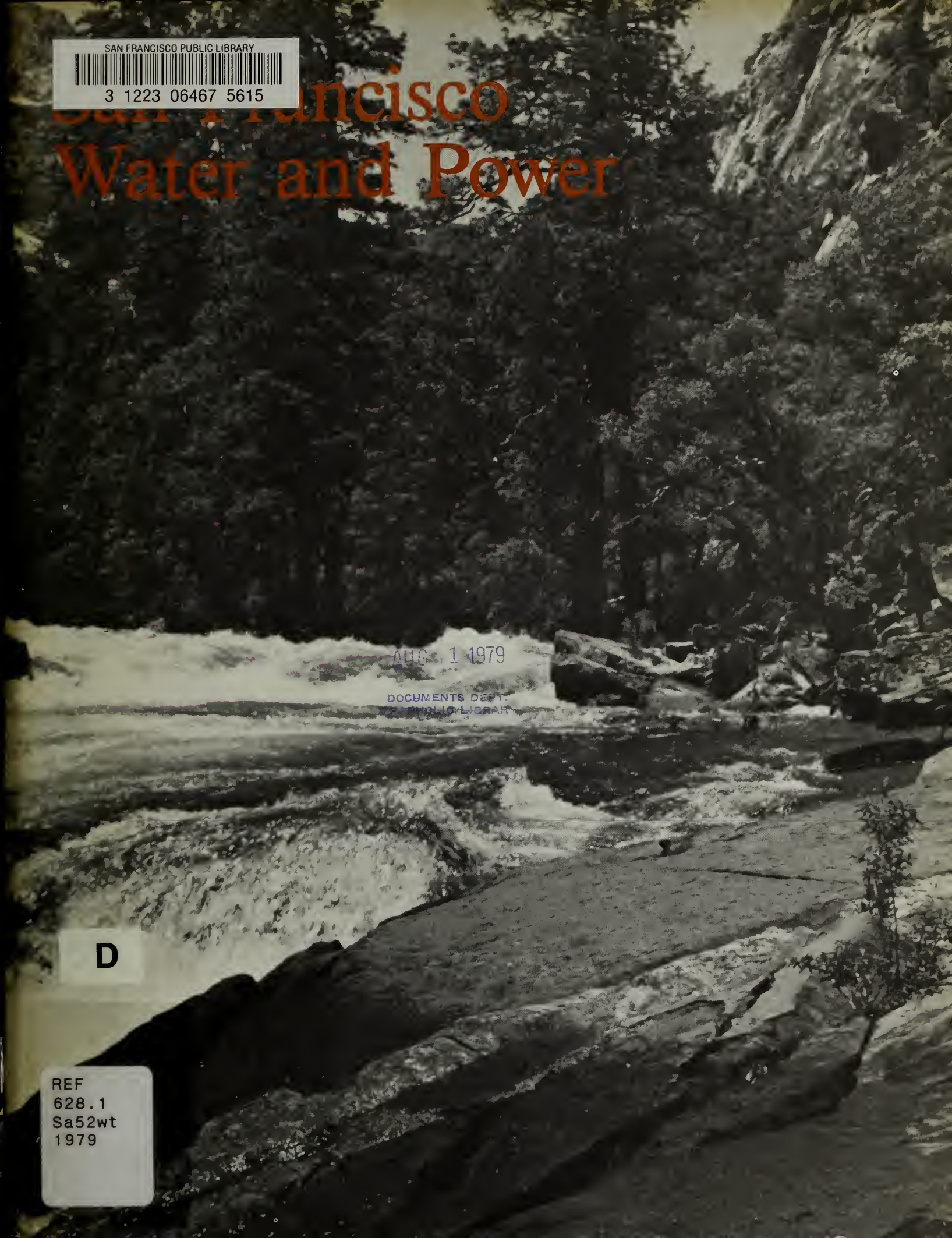

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On the cover:

The Tuolumne River in early summer, about 75 yards from where it empties into Hetch Hetchy Lake

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REFERENCE BOOK

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Published by
Hetch Hetchy Water and Power System
Ora' L. Moore, General Manager

San Francisco Water and Power

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Hetch Hetchy Water
and Power System

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of Public Utilities

Wearing the battered black hat that became a Hetch Hetchy trademark of sorts, Michael M. O'Shaughnessy gets a ride on a truck, not too gentle in the days of hard rubber tires. August 11, 1918.

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A west bank monolith, upstream a short distance from Wapama Falls, still wears the polish of the glacier which scooped out the valley for the lake that was Hetch Hetchy's predecessor centuries ago.

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Hetch Hetchy

Origin of the name . . .

We agree with the conclusion of Dr. Beecher Crampton of the Agronomy Department, College of Agriculture, at the University of California, Davis, that the name originated from "hetchetci", a Miwok Indian word for edible seeds from a grass. The grass was probably California Brome (Bromus Carinatus).

Dr. Crampton experimented with roasting seeds of the species and grinding in a mortar with a pestle, and pronounced the results "quite satisfactory".

"If indeed the Indians visiting Hetch Hetchy Valley had a favorite food grass," Dr. Crampton states, "they could scarcely have passed up Bromus Carinatus. It was easily harvested, the fruits were large, as grasses go, and were nutritious — though a great quantity needs to be accumulated."

— Oral L. Moore

Hetch Hetchy Lake, which provides 85 percent of the water serving San Francisco and its suburban customers, looking upstream past Kolana Rock on the right. The photo was taken from the mountain on the west side of the lake at a point near Wapama Falls.

Foreword

Only 35 years after Richard Henry Dana, Jr., author of the great American classic, "Two Years Before the Mast", sailed from the Bay on the brig, Pilgrim, San Franciscans were laying the groundwork for their Hetch Hetchy Project.

As the Pilgrim sailed from the Golden Gate the prescient Dana reflected in his personal log for December 27, 1835, that circumstance fits "this magnificent bay for a place of great importance".

Returning from Boston in 1859, Dana wrote again:

"How strange and eventful has been the brief history of this marvelous city, San Francisco! In 1835 there was one board shanty. In 1836, one adobe house on the same spot. In 1847, a population of 450 persons, who organized a town government . . . a sudden birth of a city of canvas and boards, entirely destroyed by fire five times in 18 months, with a loss of $16 million, and as often rebuilt until it became a solid city of brick and stone of nearly 100,000 inhabitants — with all the accompaniments of wealth and culture. Now it is the most quiet and well-governed city of its size in the United States."

Any relationship between Hetch Hetchy and the famous author would exist only in measuring his prophetic imagination. Such beginnings add understanding when reviewing the great things San Francisco accomplished in such a remarkably brief time.

This is the story of one of the greatest things that San Franciscans achieved — building the Hetch Hetchy Water and Power System.

Fate provided the precise combination of men and resources for a big job. It was no mere chain of circumstances, but a calculated series of planning and engineering steps, each with its own function. Time has proven that Hetch Hetchy's builders knew exactly what they were doing. Today, 60 years later, as water and power requirements change, the pieces can be fitted together with ease, just as planned.

San Francisco's Need

Water was the key to the development of San Francisco, and before the turn of the century it became evident to persons of foresight that the water producing limitations of the land would not permit San Francisco to become that "place of great importance" contemplated by Richard Henry Dana. So the people looked elsewhere for water.

In 1867 San Franciscans were uneasy because of the questionable adequacy of the water supply, and the reluctance of its private owners to invest capital for developing additional water sources. They started talking about building their own system.

In May, 1882, J.P. Dart, a civil engineer of Sonora, Tuolumne County, proposed a route for bringing Tuolumne River water from a point upstream from Jacksonville to San Francisco. The U.S. Geological Survey annual report of 1899-1900 contained a study which recommended Hetch Hetchy as a source for an adequate San Francisco water supply.

During the administration of Mayor James Phelan, in 1900 and 1901, City Engineer C.E. Grunsky made a detailed study of 14 possible water supply sources:

Spring Valley Water Works
Lake Tahoe
Yuba River
Feather River
American River
Sacramento River
Eel River
San Joaquin River
Clear Lake and Cache Creek
Stanislaus River
Mokelumne River
Tuolumne River
Bay Shore Gravels
Bay Cities Water Company

The investigation established the superiority of the Tuolumne River System — later called Hetch Hetchy — for the following basic reasons:

1. Quality of the water.
2. Largest amount of water available.
3. Largest and finest reservoir sites.
4. Freedom from conflicting legal claims.
5. Electric power possibilities.

(Until the 1932 City Charter established the Public Utilities Commission, development of the Hetch Hetchy system was the responsibility of the Bureau of Engineering, a unit of the Department of Public Works. Operation of Hetch Hetchy, the San Francisco Water Department, San Francisco International Airport, and the Municipal Railway was taken over by the Public Utilities Commission in 1932. A separate Airports Commission was established to operate the Airport in 1970).

City Engineer Grunsky and Marsden Manson, who was to succeed him in office, shared Mayor Phelan's enthusiasm for Hetch Hetchy. These three were quite a team.

They knew before the study was finished that the Tuolumne River had to be the answer. Quietly — and quickly — they put up their own money to send an engineer, J.P. Lippincott, into the mountains for the necessary surveys. Filing as a citizen, Mayor Phelan applied for the water and reservoir rights in the Hetch Hetchy area, and in 1903 he assigned his interests to the City. Acting publicly and in the City's name would have risked losing out to the private capital of speculators. Manson later recalled:

"If we had attempted to put an appropriation through the Board of Supervisors for

this purpose, the cat would have been out of the bag. So we paid the expense ourselves."

Six years later Manson filed personally for the rights again just to be sure everything was in order. He signed them over to the City for $1.

The long, hard fight to build a dam and related installations within Yosemite National Park was on. The Park was created by Congress October 1, 1890, but at that time it did not include Yosemite Valley and Mariposa Grove. Under the Yosemite Grant and the Big Tree Grant (signed by President Abraham Lincoln) Congress gave them to California for public park and recreation uses in 1864. The State ceded them back to the Federal government, and they were added to the Park in 1906.

The City's first application was denied by U.S. Interior Secretary E.A. Hitchcock on June 20, 1903.

The denial of the first application was reaffirmed September 22, 1903, with the explanation that the Secretary lacked authority to make such a grant. It was not until 1906, however, that it was learned that an earlier opinion of the U.S. Attorney General informed the Secretary that he did in fact have the authority.

Mayor James Phelan.

Shortly after the new year began in 1906 about 1,200 landowners in the Modesto and Turlock Irrigation Districts petitioned the San Francisco Board of Supervisors to abandon the Hetch Hetchy Project. The Board promptly adopted Resolution 6949 in February, formally abandoning Hetch Hetchy.

Enthusiastic Hetch Hetchy sponsors were becoming accustomed to road blocks, but they were unprepared for this one on the home front.

On June 21 eleven new proposals for water sources were submitted to the Board, and on July 30 Mayor Eugene E. Schmitz (who followed Mayor Phelan in office in 1902) appointed a panel of engineers to study the proposals. But the panel resigned without making a recommendation; and it was widely rumored that the engineers would not recommend the source that was apparently favored.

Recommendation or no recommendation, the Board's Committee on Water Supply selected the proposal by the Bay Cities Water Company that the City buy its system for $10.5 million. The Supervisors then asked the City Engineer's office to report on the Bay Cities properties, which depended upon water from the South Fork of the American River and the North Fork of the Consumnes River.

San Francisco's big graft investigation, pressed and largely financed by financier Rudolph Spreckels, was underway at this time. The investigation had the support of ex-Mayor Phelan and Fremont Older, vigorous editor of the Bulletin, and others. The Bay Cities deal was just another in a long series of corruptions; but it infuriated Phelan and Older.

Ultimately (in 1908) Abraham Ruef, political boss and associate of Mayor Schmitz, was sentenced to 14 years in San Quentin — and served 5 years. The Mayor, a violinist, was President of the Musicians' Union when Ruef tapped him as a candidate, was convicted and sentenced to 5 years. But his conviction was reversed by the State Court of Appeals. Sixteen members of the Board of Supervisors, who testified for the prosecution, resigned.

The graft trials of 1906, 1907, and 1908 and the tragic fire and earthquake of April 18, 1906, delayed Hetch Hetchy. But the campaign was in good and trusted hands — and the memory of flames unchecked for lack of water was too vivid. Mayor Schmitz was succeeded briefly by Supervisor Charles Boxton, one of the board members who later resigned. Then came Dr. Edward Robeson Taylor and Patrick Henry McCarthy. San Francisco was ready for James Rolph, Jr. in 1912.

Interior Secretary James R. Garfield held hearings in San Francisco, and the ensuing "Garfield Permit", revocable under certain conditions, granted rights-of-way for dams, reservoirs and aqueducts.

Hetch Hetchy's first bond issue of $600,000 for buying land and water rights was adopted at the 1908 election; and in 1910 voters approved a $45 million measure to build initial phases.

John R. Freeman, a hydraulics engineer from Providence, Rhode Island — later to become an engineer for the New York Board of Water Supply — was hired to prepare a preliminary design; and in 1912 the "Freeman Plan" was published. Through the ensuing years construction was to follow its gravity concept and general format. Freeman, a well known and internationally respected engineer, was a good advocate and defender of the Hetch Hetchy cause.

Trouble on the river persisted, however. A new Secretary of the Interior — Richard A. Ballinger, came to Washington, D.C., and on February 25, 1910, he cited San Francisco to show cause why the permit phase applying to the Hetch Hetchy Valley should not be revoked. This would have left the City with only Cherry Valley and Lake Eleanor. Ballinger inspired San Francisco's big weapon, the Raker Act.

It was now clear that no project of Hetch Hetchy's magnitude could depend upon the whims of successive administrations. San Francisco needed an act of Congress for an outright grant — and got it with passage of the Hetch Hetchy Grant, or the Raker Act.

The Raker Act

Legislation creating the Raker Act bears the name of Manteca Congressman John Edward Raker. It was signed into law by President Woodrow Wilson on December 19, 1913. (President Wilson's statement is reproduced on page 8).

The Act (HR 7207) was adopted by the House of Representatives September 3, 1913. The leader guiding it through the House was Congressman William Kent, the man who purchased over 400 acres of Marin County redwoods to save them from destruction — then gave them to the United States. The grove became Muir Woods National Monument in 1908.

The Raker Act was passed by the U.S. Senate during a night session December 2, 1913, the debate covering hundreds of pages in the Congressional Record. The Record lists scores of letters from all parts of the nation. Newspapers throughout the land took positions.

Largely responsible for the national interest were the often frightening forecasts by environmentalists. The New York Independent, a weekly magazine, carried a large photo of Wapama Falls on October 30, 1913, captioned: "Will be destroyed by the San Francisco Plan."

Hetch Hetchy, one group warned, would cause the Calaveras Big Trees, about 50 miles to the northwest, to die of thirst. Yosemite Valley, though 26 miles south, would be ruined.

Even the imposing Senator William E. Borah flirted with overkill: "I claim that it would destroy the San Joaquin Valley as ' the San Joaquin Valley will be (sic), if it (San Francisco) is permitted to use this water."

Others were not so apprehensive about San Francisco's plans for the Hetch Hetchy Valley's future. While an information officer for the National Park Service, Ansel F. Hall published his "Handbook of Yosemite National Park" in 1921.

One of the book's chapters — "Geology of Yosemite National Park" — was written by Andrew C. Lawson, Professor of Geology and Mineralogy at the University of California. Professor Lawson described how glacial action scooped out Hetch Hetchy Valley, finally lodging at the narrow gorge at the end of the valley, now the site of O'Shaughnessy Dam:

> ". . . when ice retreated a tarn occupied the basin. This tarn served as a trap for sediments brought down from the melting ice above, and the filling of the basin built out the level floor of Hetch Hetchy Valley. The lake which will soon be created in Hetch Hetchy Valley by the dam at its outlet, now being built by the City of San Francisco, will be but a restoration on a larger scale of the lake which once existed there. The new lake will seem very natural in its mountain setting."

The presidents of Harvard University and Radcliffe College and their faculties sent impassioned pleas urging the Senate to "save Hetch Hetchy" from San Francisco.

Support for San Francisco was widespread, however, coming from the California Legislature, every major city in California, and all communities in the greater San Francisco Bay area.

Significant support was provided by Governor Gifford Pinchot of Pennsylvania, former National Forester and one of the nation's most respected environmentalists.

Leading the fight for Hetch Hetchy in the Senate were such luminaries as Senators Key Pittman, Nevada; George C. Perkins, California; George W. Norris, Nebraska; Charles S. Thomas, Colorado; Henry L. Myers, Montana; and William H. Thompson, Kansas.

A master stroke of luck for the City came when the San Francisco Examiner sent a staff to Washington, D.C., and on the morning of December 2, 1913, a special Washington edition was published. A copy was placed on the desk of every member of the Senate.

The front page carried statements backing Hetch Hetchy by Thomas R. Marshall, Vice President of the United States; Secretary of State William Jennings Bryan; Franklin K. Lane, Secretary of the Interior (and a former San Francisco City Attorney); and David F. Houston, Secretary of Agriculture.

The historic Examiner also carried a

Congressman John E. Raker of Manteca.

telegram from directors of the Modesto and Turlock Irrigation Districts. At a joint meeting they had decided to throw their support to San Francisco.

The major opposition to Hetch Hetchy was vanishing.

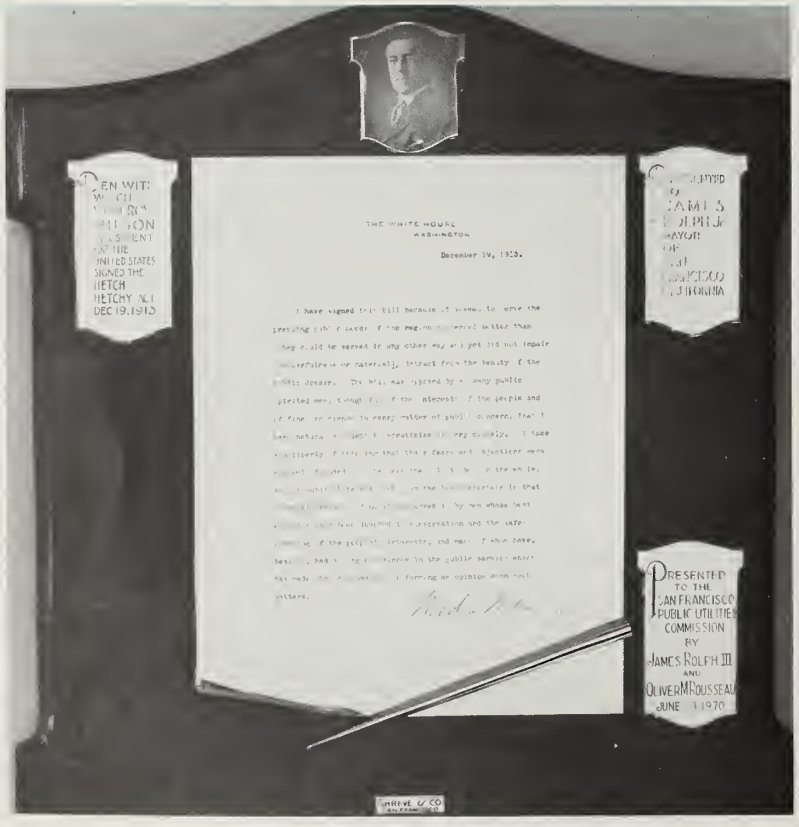
Even the Spring Valley Water Company, which had fought San Francisco at every turn for years, finally decided that the City was determined to prevail. Of telling effect was the speech to the San Francisco Board of Supervisors on May 19, 1913, by William Bourn, President of Spring Valley. The speech was read to the Senate and recorded in the Congressional Record.

"The situation today in this City," said Bourn, ". . . there is nothing as deplorable, there is nothing in my life that I regret as much as the water situation in San Francisco today. It is doing this City more harm than the earthquake ever did it."

"The City's object was opposed until this year by the Spring Valley Water Company, the irrigationists of the Turlock-Modesto Irrigation Districts, the promoters of several water schemes which the City did not want, and by a small group of men who based their objections on a love of nature and opposed creation of a lake where a canyon now exists. All this opposition, except that of the nature lovers, is withdrawn."

During the debates no opposing voice spoke more fervently than John Muir, the famous naturalist whose heart was in the Sierra. He was an organizer and became the first president of the Sierra Club, which was founded in San Francisco May 28, 1892, serving in that position for 22 years. Few of its members are unfamiliar with his famous and often quoted protest:

"Dam Hetch Hetchy! As well dam for water tanks the people's cathedrals and churches, for no holier temple has ever been consecrated by the heart of man!"


THE WHITE HOUSE
WASHINGTON
December 19, 1913.
PRESENTED TO THE SAN FRANCISCO PUBLIC UTILITIES COMMISSION BY JAMES ROLPH III AND OLIVER M ROUSSEAU JUNE 1970

The White House Washington

December 19, 1913

I have signed this bill because it seemed to serve the pressing public needs of the region concerned better than they could be served in any other way and yet did not impair the usefulness or materially detract from the beauty of the public domain. The bill was opposed by so many public spirited men, thoughtful of the interests of the people and of fine conscience in every matter of public concern, that I have naturally sought to scrutinize it very closely. I take the liberty of thinking that their fears and objections were not well founded. I believe the bill to be, on the whole, in the public interest, and I am the less uncertain in that judgment because I find it concurred in by men whose best energies have been devoted to conservation and the safeguarding of the people's interests, and many of whom have, besides, had a long experience in the public service which has made them circumspect in forming an opinion on such matters.

WOODROW WILSON

Today, as then, John Muir's name is respected by Hetch Hetchy people who share his legendary love of the wilderness and his fears for its preservation. They mention his name frequently in this beautiful and protected valley.

Today, as then, Hetch Hetchy people believe Muir was wrong — that a cruel fate, indeed, would have befallen Hetch Hetchy had the water supply project failed. For at that time the automobile was in its ascendancy; and it would have been only a matter of time before roads were built into the back country — perhaps in on the right and out on the left.

No doubt about it, one of the crown jewels of the Yosemite National Park he inspired is Yosemite Valley, 26 miles to the south. Often smoggy and reverberating from the noise of up to 40,000 visitors daily, it is hardly in tune with Muir's scheme of things. A General Management Plan "for the beginning of a new era at Yosemite" has been undertaken by the National Park Service.

Hetch Hetchy's waters, which sustain nearly two million people in the San Francisco Bay region, are not a barrier to keep people away from the absolute stillness of the back country wilderness. For those willing to forsake autos, campers, or motorcycles good hiking trails are open from the trail head at O'Shaughnessy Dam, the best of them constructed by the City and County of San Francisco.

One might wonder when a battle is won or lost.

Some Hetch Hetchy critics called the Raker Act a gift to the City of San Francisco. Read the conditions and obligations imposed upon the City and decide for yourself:

1) Recognize the prior rights of the Turlock and Modesto Irrigation Districts to receive water they can beneficially use — up to specified amounts of the natural daily flow — for direct use and storage;
2) Construct scenic roads and trails in Yosemite National Park and donate them to the United States;
3) Get started on the work of dam building and complete it as rapidly as possible;
4) Enforce specific sanitary regulations: (a) no human waste or refuse shall be placed in waters of any reservoir or stream or within 300 feet thereof; (b) sewage from any permanent camp or hotel within the watershed shall be filtered by natural percolation through porous earth or otherwise adequately purified or destroyed; (c) no person shall bathe, wash clothes or cooking utensils, or water stock, or in any way pollute the water within the limits of the Hetch Hetchy Reservoir or any reservoir constructed by grantee, or within one mile of reservoir in streams leading to it; (d) pay cost of any Interior Department inspection to secure compliance; and (e) if at any time grantee deems sanitary regulations inadequate to protect purity of water supply, filter plant shall be installed or other means taken;
5) Develop electric power for municipal and commercial use;
6) Shall not divert beyond the limits of the San Joaquin Valley any more of the waters of the Tuolumne watershed than, together with the waters which it now has or may hereafter acquire, shall be necessary for its beneficial use for domestic and other municipal purposes;
7) Pay an annual rental graduated from $15,000 up to a maximum amount of $30,000 after 20 years;
8) Shall not sell or give Hetch Hetchy water or power to a private person or corporation for resale.

Congress pointedly disclaimed any intent to interfere with the laws of the State of California relating to the control or appropriation of water. This was of extreme importance to San Francisco because it holds its water rights under California law — not under the Raker Act.

Originally San Francisco was looking for a water source capable of adding 60 million gallons daily to the local supply. But on the advice of the Army Board of Engineers in 1913 it assumed leadership for developing water resources to satisfy the entire San Francisco Bay region until well into the 21st century.

The City had shouldered a heavy load; and it was fortuitous, perhaps, when in the early twenties cities in the East Bay decided to develop their own supply from the Mokelumne River, leaving Hetch Hetchy to provide primarily for the needs of the San Francisco-San Mateo-Santa Clara Peninsula.

Members of Congress and President Wilson regarded the Raker Act as an excellent demonstration of the "conservation for use" policy, whereby advantages to vast segments of the population and the general public welfare rendered any damage to the environment slight by comparison.

The City of San Francisco accepted the terms of the Act in the Spring of 1914, and the Hetch Hetchy construction program was initiated immediately.

Though it was to warm up periodically during the following years, the fight for the rights to build the Hetch Hetchy Project was over.

"As to my attitude regarding the proposed use of Hetch Hetchy by the City of San Francisco . . . I am fully persuaded that . . . the injury . . . by substituting a lake for the swampy floor of the valley . . . is altogether unimportant compared with the benefits to be derived from its use as a reservoir."

— Governor Gifford Pinchot

Hetch Hetchy Today

The Tuolumne River's source is a perpetual glacier on Mt. Lyell, which, at 13,090 feet, is the highest point in the 459 square mile Hetch Hetchy watershed. Sloping west from the crest of the Sierra, the rugged granite mountains, largely without soil or vegetation, form an ideal watershed. About 92 percent of it is above 6,000 feet elevation and relatively free of habitation.

Participating in the John R. Freeman report to a special Board of Army Engineers appointed by President William Howard Taft to review the Hetch Hetchy "matter", a well known sanitary engineer, Allen Hazen, stated:

"It would be difficult to conceive of a more perfect gathering ground or one better adapted to produce water of greater purity. The water will be almost ideally safe."

After examining all alternative sources of supply mentioned as available to San Francisco, this board of engineers reported to the Secretary of the Interior on February 19, 1913, and recommended that the Hetch Hetchy source be selected because it was the most available, the least expensive and most economical, and afforded the greatest potential for hydroelectric development.

Hetch Hetchy's mountain water supply system utilizes three storage lakes:

- Hetch Hetchy
  Capacity — 360,400 acre feet*
- Lake Lloyd
  Capacity — 268,800 acre feet
- Lake Eleanor
  Capacity — 27,100 acre feet

Hetch Hetchy is on the Tuolumne River, Lake Lloyd on Cherry River, and Lake Eleanor on Eleanor Creek. The latter two streams are tributaries of the Tuolumne. Each year the runoff from rainfall and melting snow is collected behind the dams. Water from Lakes Lloyd and Eleanor is utilized to generate power at Dion R. Holm Powerhouse, and then to meet priorities of the Modesto and Turlock Irrigation Districts downstream.

Water from Hetch Hetchy is drawn upon mainly for the domestic water supply of San Francisco and its suburban users. It flows through a spectacular series of tunnels, pipelines, inverted siphons, and powerhouses — all part of the 148-mile Hetch Hetchy Aqueduct.

A total of 77 miles of the aqueduct flow is through tunnels and 71 miles in pipelines — entirely by gravity. The engineers designed a water supply route entirely free from the great and unending expense of pumping. It is a system in which the high quality Sierra water is completely enclosed and protected for the entire distance.

The terminal storage point is Upper Crystal Springs Lake on the San Mateo County Peninsula. Now, however, a portion of the water is diverted into the Crystal Springs Bypass Tunnel for direct service to San Francisco and north Peninsula users.

On its way to San Francisco through the aqueduct Hetch Hetchy water turns the turbines of Robert C. Kirkwood Powerhouse and Moccasin Powerhouse; and water from Lake Lloyd and Lake Eleanor operate Dion R. Holm Powerhouse. Revenue generated by the powerhouses pays for all Hetch Hetchy operations, maintenance, and improvements; finances Hetch Hetchy's operation of the Municipal Railway electrical distribution network; and supplies all municipal power needs in San Francisco at cost. Hetch Hetchy regularly contributes generously to the City's general fund.

Planning and building the Hetch Hetchy system involved a remarkable combination of determination, intuition, professional engineering skill, and a lot of common sense. It is a masterful achievement, and it was accomplished in such a manner that none of the work has had to be done over. Additions can be made to various segments without changing the basic design of the system.

And it was built as economically as possible. But where additional expense would prevent future outlays of money and endless maintenance the City provided the funds, although painfully at times.

* An acre foot will cover an acre of land a foot deep, and contains 325,851 gallons.

Planning and Building

Michael Maurice O'Shaughnessy in 1915. A native of Ireland, he was hired as San Francisco City Engineer to run the Hetch Hetchy Project by Mayor James Rolph in 1912.

The architects of the "Hetch Hetchy Project" were City Engineer Carl E. Grunsky and his successor, Marsden Manson. Grunsky directed the surveys that selected the Tuolumne River as the City's source and acquired some of its rights. Manson devoted his time almost exclusively to the project for 12 years and continued his efforts even after he was out of office. In 1908 he had a survey party in the mountains under Drenzy Jones, a former Tuolumne County surveyor, including two San Francisco assistant city engineers, Leslie W. Stocker and Louis Mercado.

Then there was Michael Maurice O'Shaughnessy.

With a Bachelor of Engineering degree from Royal University in Dublin (later to become the National University of Ireland), O'Shaughnessy got off a ship in San Francisco in April, 1885, after a trip around the Horn. He found no employment in San Francisco and went to Mill Valley where he helped build Marin County's Alpine Dam. He also designed the Mill Valley street system. The house he built there is still one of Mill Valley's more substantial homes.

At 48 years of age O'Shaughnessy was chief engineer for the Southern California Mountain Water Company in San Diego when Mayor James Rolph, Jr. appointed him City Engineer on September 1, 1912. Rolph had become Mayor only nine months earlier — on January 8, 1912.

The times were right for a man like Rolph to become Mayor of San Francisco. He was to become a dynamic and powerful chief executive, and the people trusted him. He would serve as Mayor until 1932, when he became Governor of California.

"You will answer only to me," Mayor Rolph informed O'Shaughnessy, and the peppery Irishman took him at his word. It was no accident that the Hetch Hetchy staff called him "the Chief".

O'Shaughnessy was a first rate engineer, but his political perceptivity was unsurpassed. And as the right hand of the masterful Rolph it became clear that he would make the Hetch Hetchy Project move.

But where "Sunny Jim" was charming and gracious and made every stranger his friend, O'Shaughnessy, though respected by those who worked for him, could become a bit abrasive — a characteristic that was to give him trouble as the project was moving down the home stretch.

Much has been written about the colorful career of O'Shaughnessy, the man of action (Jack London was one of his admirers). There were those who listened to the Raker Act debates in the Senate who came primarily to see O'Shaughnessy.

Somewhat neglected over the years was the secret of Hetch Hetchy's phenomenal construction successes. Behind O'Shaughnessy was one of the most talented groups of engineers that ever worked together. Through the years Hetch Hetchy attracted gifted engineers — a capability it retains today.

Step by Step

The fascination of the Hetch Hetchy story is in its segmented construction — separate simultaneous contracts spanning a distance of 148 miles, ultimately uniting precisely . . . dams in the high country, tunnels in all areas, pipelines in the San Joaquin Valley, and even across San Francisco Bay. That is how it was built, and that is how it will be described.

How do you build a major dam, water tunnels, and powerhouses in this rugged and remote country with little or no access? Clearly, the preliminaries required careful planning.

First, some form of high capacity, reliable transportation would be needed to carry heavy machinery, materials and supplies, and men into the mountains to the site of the new dam and other project auxiliaries. Ideally, it should be a railroad.

So the City built one — the Hetch Hetchy Railroad, 68 miles long, from Hetch Hetchy Junction 26 miles east of Oakdale to the site of O'Shaughnessy Dam. It cost $2 million and made and saved many times that amount. Completed in October, 1917, it utilized six City locomotives and one rented locomotive operating day and night.

The Hetch Hetchy Railroad operated as a common carrier under rules of the California Railroad Commission (later to be named the California Public Utilities Commission). Mayor Rolph was President of the railroad. O'Shaughnessy was Vice President and General Manager. It was a "different" railroad and even though it had to publish time tables and tariffs and abide by railroading practices, there was considerable informality in its operation — the management consisted of engineers, not railroaders.

Even though its function was to keep feeding the job with materials and supplies, primariy bulk cement, it had a contract to carry the U.S. mail, and provided passenger service. In order that San Franciscans could follow Hetch Hetchy's development first-hand weekend excursions were arranged.

Parties ranging from 40 to 100 persons left the Ferry Building Friday nights and took the Southern Pacific or Santa Fe Railway from Oakland, arriving at Hetch Hetchy Junction early Saturday morning. Leaving their Pullman sleepers at Oakdale, they were taken on a City excursion train to spend Saturday and Sunday viewing work at various camps.

Meals were served at the City's boarding houses. Upon returning to Hetch Hetchy Junction Sunday evening, the visitors boarded their waiting Pullmans and arrived in San Francisco Monday at 8 a.m. The fare, representing the actual cost of the excursions, was about $30.

With most of its work finished in the mid-1920's, the railroad was used for another 20 years, mostly for wintertime supply and maintenance while roads were snowbound. Tracks were removed in 1949. The present road from Camp Mather to O'Shaughnessy Dam uses the track bed.

Innovation was a way of life on the Hetch Hetchy Project, and this White track bus was a case in point. The two-ton rail vehicle with a capacity of 27 passengers was converted later to a track truck. Photograph, September 27, 1922 at Mather.

The Sawmill

Lumber was required for construction of camp buildings, concrete forms, tunnel timbering, and miscellaneous structures. A sawmill was needed.

So the City built one. Located at Canyon

Logs were hauled in by donkey engines to the Hetch Hetchy sawmill on skidroads to avoid destruction of small growth. Redwoods and other choice trees were not cut. The mill pond became the swimming pool at Camp Mather, the summer recreation facility operated by the Recreation and Park Department. Formerly called Hog Ranch, it was renamed after Stephen T. Mather, the first Director of the National Park Service. Photograph, August 15, 1921.

Ranch, 4-1/2 miles from Hetch Hetchy, the new mill was working when the railroad was completed. It was later moved to Hog Ranch, which was renamed Mather in honor of the man who insisted that the environment be harmed to the least possible degree. Where harmed it should be restored.

This man was Stephen T. Mather, named first Director of the National Park Service when it was created by Congress in 1916. Mather, who was a newspaper reporter before involving himself in various business enterprises, was born in San Francisco July 4, 1867.

The mill pond became the swimming pool that now serves Camp Mather, the summer recreation camp operated by the City's Recreation and Park Department. Visitors would be hard pressed to find evidence of logging. Under the supervision of sawmill superintendent Ben Shaw, selective logging left large evergreen trees untouched. Logs were dragged in by donkey engines on skidroads, not through the under growth. By June 30, 1924, a total of 23.1 million board feet of lumber, including the output of the former mill site at Canyon Ranch, had been manufactured by the City's mill.

The Hetch Hetchy Railroad's No. 5, photographed at dam site headquarters May 30, 1921. The track bed is now a tree-lined roadway to O'Shaughnessy Dam.

Early Intake Powerhouse

A good, dependable source of electrical energy was needed to run construction tools and equipment, and that meant building a powerhouse.

So the City built one — the tiny Early Intake Powerhouse, with three Pelton-Francis turbines directly connected to three 2,300-volt, 1000 kilowatt generators. Transmission lines operating at 22,000 volts were extended 11 miles east to the O'Shaughnessy dam site and 22 miles west to Moccasin. A 2-mile line was taken into Groveland, the location of Hetch Hetchy headquarters. This system was built under the supervision of Nelson A. Eckart, Chief Assistant Engineer.

Water to assure continuous operation of the construction powerhouse was essential, and a storage reservoir was needed.

So the City built Eleanor Dam, 1,260 feet long and 70 feet high, which raised the level of Lake Eleanor, a typical shallow glacial lake. A 3-mile aqueduct was constructed to carry stored water from Lake Eleanor and water from the natural flow of Cherry River to the powerhouse at Early Intake.

Construction of the dam, a low, slender multiple arch structure, began in August, 1917, concurrent with construction of Early Intake Powerhouse. It was completed in only 10 months. The powerhouse began operating in May, 1918, and in 16 years it produced power for City construction use valued at $550,000 and $750,000 in cash revenue from the commercial sale of power. It continued to operate until 1967.

Hetch Hetchy crews started building Eleanor Dam in August, 1917, and 10 months later it was a consistent supplier of water to Early Intake Powerhouse.

Groveland

Life had been slow and jobs scarce in Groveland and its neighboring community, Big Oak Flat, but Hetch Hetchy changed that. The City built a 2-story office headquarters building, a fully staffed hospital (a doctor and three nurses), railroad shops and other buildings. Early Intake Powerhouse brought electricity to the town; and at Hetch Hetchy's invitation Groveland tied into its sewer system. It shared Hetch Hetchy's water supply, and still does. Project workers helped Groveland and Big Oak Flat build much needed roads. Chief O'Shaughnessy was delighted with a baseball team that played a creditable game under the Groveland flag.

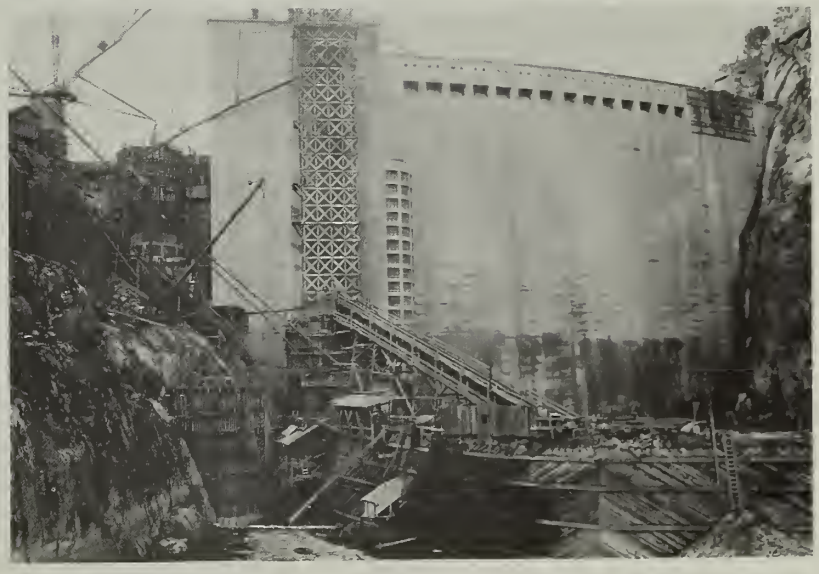
Thanks also to Hetch Hetchy, the little town outdid itself in contributing to the spirit of the roaring 20's. In spite of prohibition liquor could be found. The women who were attracted to Groveland were extremely friendly, one aspect of Hetch Hetchy that the townspeople could have done without, and so could the families of project officials.

O'Shaughnessy Dam

The contract was awarded to the Utah Construction Company of San Francisco on August 1, 1919, and O'Shaughnessy Dam construction was underway.

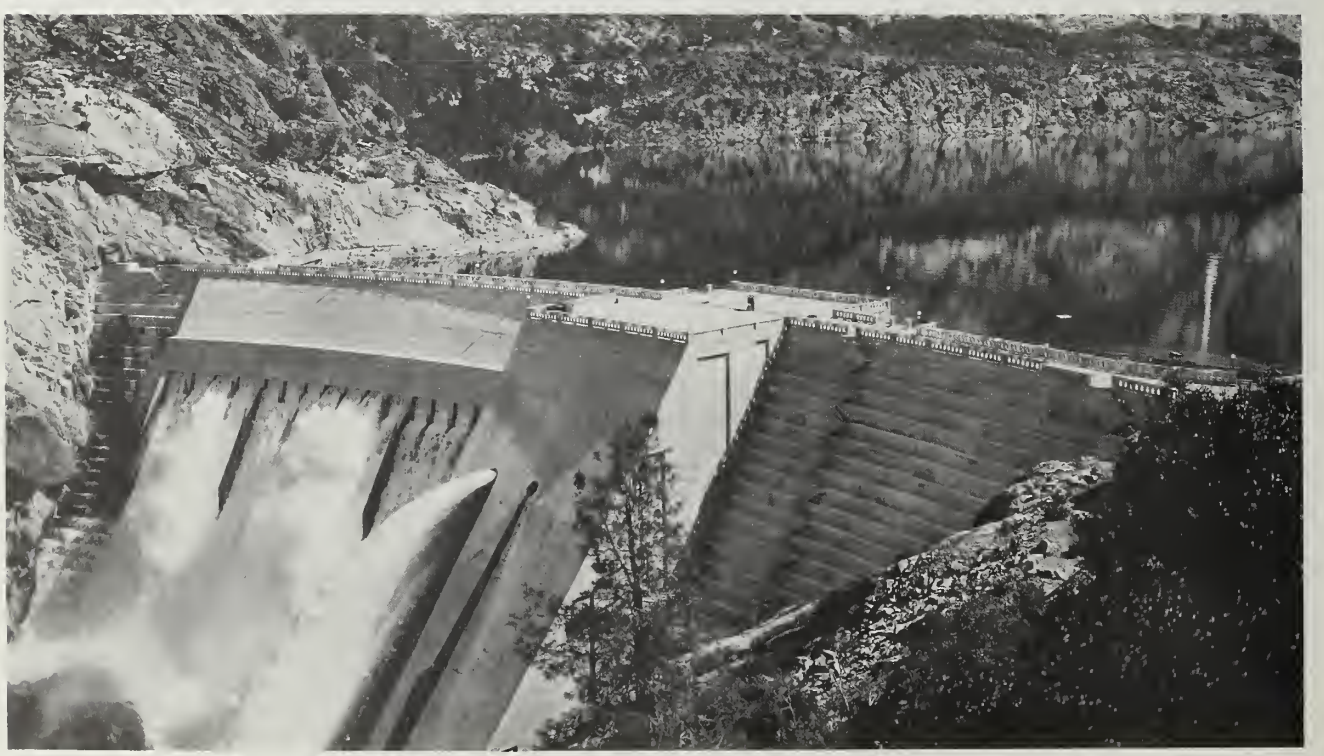
The big dam is made of cyclopean concrete, plain concrete with about 8 percent of granite plums, or blocks of stone ranging in size from 1 cubic foot to 5 or 6 cubic yards imbedded in the mass. Built in the arched gravity fashion, it has five vertical contraction joints, sealed by strips of sheet copper, with an inspection well and ladderway installed at each contraction joint.

Early planning considered 30 feet ample depth for the dam's foundation; but wash borings and diamond drill borings disclosed that the dam site was at the terminal moraine of an ancient glacier — that the river channel between the cliffs contained many large boulders, with thin intervening beds of sand, to depths of 90 feet or more below river level. It was necessary to excavate to 118 feet at the deepest point of the cut-off wall. Bedrock was encountered at 61 feet at the downstream toe of the dam and 101 feet at the upstream toe.



Top photo: A pre-historic glacier put them there and a small power shovel is helping clear the boulders from the stream bed in preparing for the foundation of O'Shaughnessy Dam (December 14, 1920). The lower photo taken January 18, 1923, shows the upstream face as completion nears. The grilled structure at lower left is the entrance to the diversion tunnel built to transfer the Tuolumne River channel from the dam base during construction.

August 15, 1921, photo at upper left — preparation of the downstream foundation of O'Shaughnessy Dam. Upper right, November 20, 1921 — the dam is rising, and it is a rigger's paradise. Lower photo — the dam is finished (dedicated July 7, 1923). Initial height was 226.5 feet.



A major feature of preliminary construction was driving a 1,000-foot diversion tunnel, 23 feet wide and 25 feet high, through solid granite to carry Tuolumne River water past foundation excavation during construction of the dam. Three of the dam's 12 outlet conduits through which reservoir water can be released were installed in the tunnel, and concrete poured around them.

Concrete operations were carried on day and night, summer and winter. During extremely cold weather a heating plant provided warm water to keep the concrete mixture from freezing. The one-month record for pouring was 41,178 cubic yards — for one day, 2,000 cubic yards.

During nearly four years of construction the scope of the work and big engineering names involved attracted national interest. Yosemite campers visited, most arriving in large open buses from the Valley, taking special gasoline propelled cars to the cliff above the dam. They were lowered to the floor of the valley on an inclined cableway.

On completion to its initial height of 226.5 feet above stream bed the dam, capable of storing 206,000 acre feet of water, was dedicated July 7, 1923.

Several hundred people gathered for the dedication, many of them arriving on a special train from San Francisco. The dam was symbolically turned over to the City by W.H. Wattis, President of Utah Construction Company, and accepted by Timothy A. Reardon, President of the Board of Public Works. Introduced by Supervisor J. Emmet Hayden, "Chairman of the Day", Mayor Rolph delivered an address. He was followed by Senator James D. Phelan and then by Chief Engineer O'Shaughnessy, who first introduced his assistants, then explained the entire project.

Mountain Tunnel

Excitement mounted in the summer of 1917 when Hetch Hetchy employees started work on the Mountain Tunnel which extends 19 miles from Early Intake to Priest Reservoir. Completed in 1925, it cost $11.5 million.

The tunnel is unlined for 38 percent of its length which was drilled through solid granite. This portion is 13.5 feet in diameter. The remainder is concrete lined and is 10 feet in diameter. The horseshoe-shaped tunnel was designed for a flow capacity of 470 million gallons daily.

When bids were opened August 22, 1917, O'Shaughnessy considered them "extravagantly" high, and all were rejected. Hetch Hetchy forces were assigned to the job, and most of them were rugged tunnel mining Swedes. Whereas the excruciatingly difficult work took the best of men, it also put the skill of engineers to the test.

Excavation was carried on from 12 working faces, and this meant that all the "headings" had to join up, vertically and horizontally, when crews approaching each other "holed through". Four of the working faces were portals, four were from adits (more or less horizontal passageways leading to the tunnel), and four from the bottoms of two shafts. The Second Garrote shaft was 786 feet deep and the Big Creek shaft 646 feet.

Muck trains drawn by powerful four-wheel battery operated locomotives hauled blasted rock out of the tunnel on 2-foot gauge tracks. Electric mucking machines were used for loading materials in all headings except from the shafts, where smaller, air-operated machines were

used. At the shafts everything — men, equipment, and supplies — entered the tunnel in big buckets lowered on cables. The buckets were large enough to carry five men at a time; and just the ride down the dark, dripping shaft was enough to frighten some visitors away.

Tunnel progress varied according to the type of ground encountered, from 300 to 700 feet a month. Most of the tunnel lies an average of 1,000 feet below the surface. At one point, about 5 miles from Early Intake, the tunnel was interrupted by 225.5 feet of 9.5-foot diameter steel pipe which crossed the gorge of the South Fork of the Tuolumne River. (About 50 years later a U-shaped tunnel under stream bed replaced this pipe).

Hetch Hetchy had good men on the tunnel job and did everything it could to retain them. They were housed in good wood buildings — heated, well lighted, and ventilated. They were served excellent food.

Hetch Hetchy Hospital

The City opened its hospital in a new two-story building in Groveland in December, 1918. It was conveniently located near the Hetch Hetchy Railroad tracks. Operated initially under contract with Dr. E.T. Gould of Sonora, the hospital was fully equipped. Dr. Gould was succeeded by Dr. Homer Rose.

Then on April 1, 1921, Dr. John Paul Degnan, who was to become a familiar and much loved character in the mountains, took charge of the hospital and ran it until its work was over. "Doc Degnan", described by Louis T. McAtee, Hetch Hetchy Construction Engineer, as "the finest construction doctor I ever knew", retired from a Livermore practice in 1942. He died on January 3, 1974.

Priest Dam — Moccasin Powerhouse

In autumn, 1921, work began on Moccasin Powerhouse and Priest Dam on Rattlesnake Creek to create a regulating reservoir for forebay capacity and flexible operation of the powerhouse, 1,316 feet below.

The water from Priest, the full flow of the aqueduct, enters a 5,370-foot power tunnel narrowing from 19 feet in width to 13 feet, connecting with three penstock pipes 5,349 feet long.

Moccasin Powerhouse is on Moccasin Creek at the foot of the old Priest Grade, which was a dreaded part of the early stagecoach route to Yosemite Valley.*

Designed in California-Spanish style by Architect H.A. Minton, it was 225 feet long, 98 feet wide, and 67 feet high. It is a steel frame building with massive concrete foundations resting on bedrock and with reinforced concrete walls. It contained four generators rated at 20,000 kilowatts each.

A multitude of contracts was underway in the Moccasin area, and their coordination required a near magic touch.

Among the contracts for furnishing and delivering equipment and construction in the huge Moccasin power system development were:

Powerhouse traveling crane, four 25,000 horsepower Pelton** water wheels, eight gate valves, four 20,000 kilowatt generators, structural steel delivery and erection, mile long penstocks, and many more.

The cost of the Priest-Moccasin system,

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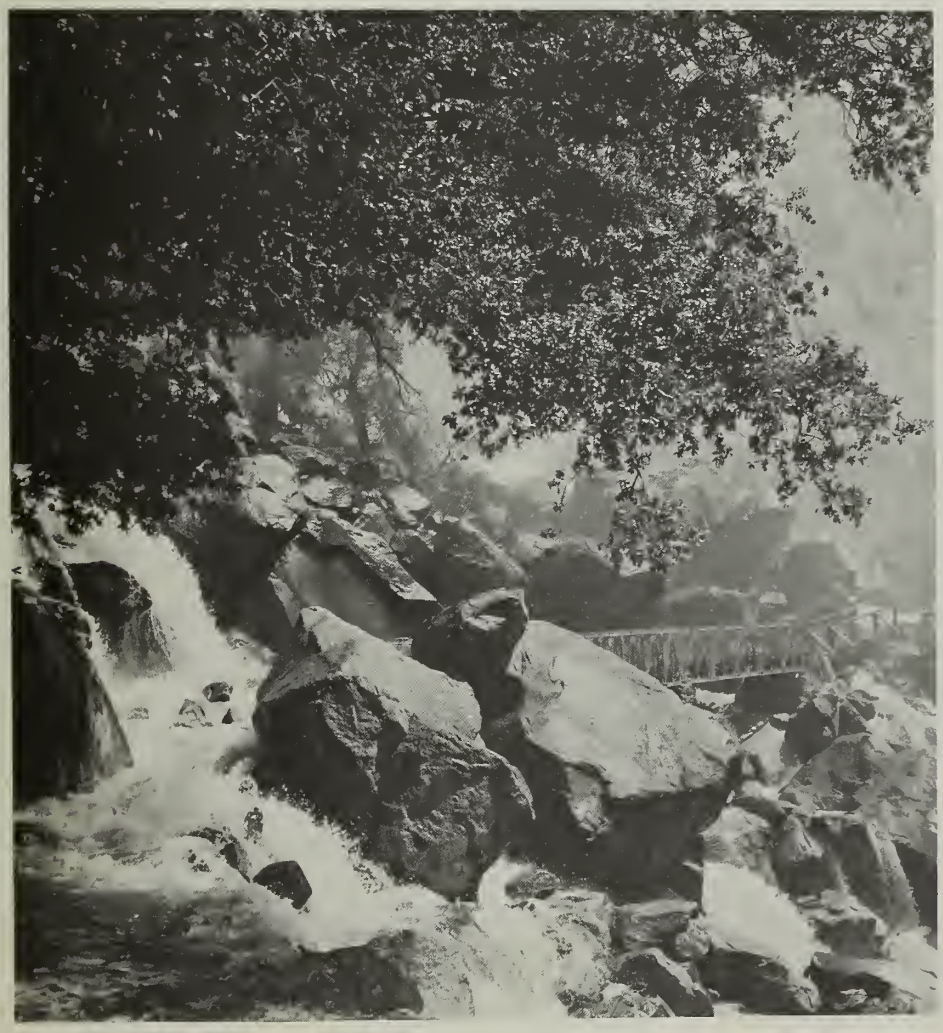
* Old Priest Grade climbed 1,575 feet in two miles. The new grade (State Route 120), across Grizzly Gulch from the old road, makes the same climb in eight miles. From the Grizzly and Eureka mines on the north side of the gulch came some fine gold leaf specimens. William Priest and his wife, the widow of Alexander Kirkwood, operated Priest's Hotel (or Priest Station) at the top of the grade. The new road was also named after Mrs. Priest, who died in 1905.

** The Pelton water wheel was invented by Lester A. Pelton, a Yuba County, California, millwright, who patented it in 1880.

Canyon walls are alive with water falls in the Spring at Hetch Hetchy, and every cliff seems to be oozing water — as in this photo of the inundated City-maintained trail south of Wapama Falls.



though modest by today's standards, was considerable at the time: Priest Dam, constructed by Hetch Hetchy forces, $1 million; Moccasin Power Tunnel, $1.3 million; penstock pipes, $2.5 million; Moccasin Powerhouse and machinery, $2.4 million.

The powerhouse's "afterbay", a re-regulating reservoir to reverse the function of the Priest regulating reservoir, was created by construction of Moccasin Dam, 70 feet high, across Moccasin Creek. The dam was built of earth and rock fill and completed in 1929. Here water was to be conveyed directly into the aqueduct's Foothill Tunnel. Since it must be discharged from the powerhouse in quantities proportionate with electrical energy demands — and since the flow into the aqueduct must be uniform — the purpose of the reservoir becomes obvious.

The original Moccasin Powerhouse went into service in 1925, and during its 44-year life it became known as "the cash register for Hetch Hetchy construction", producing electrical energy worth $115 million to the City.

Moccasin, U.S.A.

Clustered around the powerhouse complex is the little town of Moccasin, owned by the City and County of San Francisco, where most of the Hetch Hetchy construction and maintenance families live. The lawns are green and well-maintained, ringed by an abundance of shade trees —

an attractive and comforting sight to approaching visitors. Moccasin's unique charm comes mostly from the intimate neighborliness of its residents.

Much has been expected of the Superintendent of Operations at Moccasin, and ideally the position calls for one who is versatile and who has the Moccasin spirit. Past Superintendents have become the City's political presence in Tuolumne County, the "Mayor", the marriage counselor, and the arbiter and disciplinarian to deal with personnel difficulties.

There are times, of course, when the Superintendent must consult Hetch Hetchy's General Manager; but word of these problems rarely reach the City. They are solved in the mountains.

John M. Woods, who left in 1964 to become General Manager of the Municipal Railway, was typical of these Superintendents. Woods even worried when Moccasin children ran into scholastic difficulties at school. This situation could find him supervising night home work in the administration building.

Foothill Tunnel

Started in 1926 and completed in 1929 at a cost of $8 million, Foothill Tunnel is 15.8 miles long and extends west through the Sierra foothills to a portal near Oakdale. It, too, has a colorful history.

Five miles west of Moccasin tunnel construction was interrupted by the Tuolumne River Canyon at Red Mountain Bar. The half-mile crossing at this point was accomplished by an inverted siphon — a 9.5-foot steel pipe embedded in concrete.

Though the siphon was not needed at this time, and would not be used for several years, Hetch Hetchy was under pressure from the Modesto and Turlock Irrigation Districts to get it finished. The Districts were building the first Don Pedro Dam downstream, and the reservoir would soon fill. The lowest point of Hetch Hetchy's siphon would be 80 feet under water.

It was necessary to lay 770 feet of 9.5-foot steel pipe in a trench blasted in the bedrock of the river bottom, and cover it with concrete from 18 inches to 2 feet thick. The interior of the pipe was lined with cement mortar 1.5 inches thick. To lay the pipe across the canyon it was necessary to divert the flow by building a cofferdam half way across. As work progressed the same routine was followed for the other half.

Because working roads and trucks of this era were far less sophisticated than today's, Hetch Hetchy chose to build a small railroad, a field the engineers were now proficient in. Their narrow gauge line carried equipment and supplies directly to workmen in the tunnel itself. The men also rode the railroad, which became longer as the job went on. The men and equipment were carried across the canyon on a half-mile cable "high line" which was capable of carrying 5-ton loads.

Work on Foothill Tunnel began with Hetch Hetchy workers at six camps under the direction of the City Engineer. They installed all required "appurtenances" (a favorite word of engineers), such as water systems, power and telephone lines, roads and camps, and other construction facilities. They also drove about 1,000 feet of tunnel in each of several headings so private contractors interested in bidding could study the nature of the ground to be tunneled.

Chief O'Shaughnessy was frequently infuriated when bidders included excessive amounts for "unknown hazards". When bids came in Hetch Hetchy decided to let contractors do about half of the tunnel work and do the other half with its own forces. This led to keen competition in tunnel drilling, and the Hetch Hetchy men were easy winners — breaking existing tunnel driving records three times. Their best was September, 1927, when they advanced 803 feet.

O'Shaughnessy reported later that tunneling costs for Hetch Hetchy work came to $35.53 a foot, and the contractor cost was $40.49. Hetch Hetchy costs for placing concrete lining amounted to $36.11 a foot, against $47.38 by the contractors.

Coast Range Tunnel

San Francisco and the Bay area were buzzing with excitement as Hetch Hetchy moved closer and closer. And now one of the largest and most dramatic projects was virtually on the City's doorstep — driving a 28.5-mile tunnel beneath the Coast Range Mountains. It was formidable to some and frightening to others; but Hetch Hetchy was eager to go. The number of critics seemed to multiply as construction drew nearer, so, as might be expected, O'Shaughnessy began to encounter more serious controversy.

Why not lay pipelines over the mountains and pump the water over the top, some asked. It would take less time, and would cost less. But the engineers pointed out that pumping is expensive, and the cost would be with the City forevermore.

The Chief had scheduled the start of the job in the winter of 1925; but the Board of Supervisors waited until 1927 to approve his budget, and then work started immediately.

The tunnel, 10.5 feet in diameter, extends from Tesla Portal, beneath the Coast Range Mountains to Irvington Portal, which is located near Mission San Jose in the City of Fremont. It is entirely concrete lined — three feet thick in some places.

Cost of the tunnel was $28 million, and money was hard to find, particularly during the depression years — so hard to find that several headings were shut down for varying periods of time to "conserve funds pending the sale of bonds to finance the work".

Location of the tunnel follows the general line recommended in the Freeman Plan. But after detailed geological studies and diamond drill borings, O'Shaughnessy's engineers moved the route to the south to avoid as much as possible the danger of intercepting volatile and poisonous gases, particularly methane, the product of organic decomposition in marshes and mines.

In July, 1930, however, a crew encountered explosive gas; and in the explosion that followed 12 lives were lost. Controversy flared anew and several investigations were conducted. Investigators concluded that Hetch Hetchy tunneling had been carried on under the strictest safety methods ever used in California. An Alameda County Coroner's Jury held Hetch Hetchy and the City blameless.

While not minimizing the seriousness of the tragedy, the State Industrial Accident Commission recognized the safety precautions taken by Hetch Hetchy. In fact C.H. Fry, the Commission's Superintendent of Safety, impressed by the magnitude of the tunnel project, said that if a private contractor had started the tunnel, he would soon have let the bonding company forfeit the bond and would have walked away from the job.

"I trust," Fry stated, "that some day there may be a complete report of this project made and credit given to the men who have worked so hard and under such unusual and difficult conditions with their only reward to date of unjustified, adverse criticism". Four years later the Commission gave Hetch Hetchy a certificate of honor for safety achievement.

Scott Turner, U.S. Bureau of Mines Director, added: "Performances of this kind indicate that tunnels can be driven with comparative freedom from casualties, and thus give us all new hope that in the future accident rates will continue to decrease."

Though it was impossible to isolate the

The tunnel crew pauses after a shift's work at the Mocho Shaft of the Coast Range Tunnel January 3, 1934 — muckers, tunnel "stiffs", shopmen, and timekeepers. Tunnel foreman Pete Peterson is at the far right in the front row.

cause of the explosion, it was believed to have come from any of three sources — someone violating the strict rule against smoking, flipping an electric light switch in a prohibited area, or an electric motor spark.

Critics voiced dire warnings about earthquakes, but Hetch Hetchy engineers were ready for that, too. Gunite tunnel lining was 2-1/2 to 3 feet thick and mixed with an extra high cement content. The gunite maintained integrity in places where the tunnel passes directly through the fractured junction of two earthquake fault lines. Some sections of the concrete lining have flexible joints in anticipation of movement. Periodic inspections over 44 years of constant use show the tunnel to be as sound as on the first day it carried water.

Lloyd T. McAfee, Construction Engineer during the mountain work, was appointed Chief Engineer and General Manager of Hetch Hetchy Water and Power after creation of the Public Utilities Commission in 1932, the first person to hold this position.

Hetch Hetchy veterans of the Foothill Tunnel project began the Coast Range Tunnel undertaking; but the new 1932 City Charter required public bidding for its completion. Hetch Hetchy had the right to bid, too, however, and submitted a bid of $5,257,665 — which was $557,670 below the next bid. Hetch Hetchy forces finished the job with about $1.5 million left over.

Swelling ground was one of the most perplexing hazards the builders encountered. During one 24-hour period the 18-foot tunnel bore was compressed three feet from all sides, reducing heavy 18-inch square timbers to kindling wood. In a few days the tunnel became so small that an individual could crawl through on hands and knees only with difficulty. Ordinary guniting methods were useless, because the quick "squeezing" would not give the cement time to set.

Engineers solved the problem with a new system of ground support. The tunnel was excavated oversize — in many places the ground began swelling the moment it was opened. Attempts to timber were abandoned, and instead annular (or ringlike) bands of gunite concrete were used to hold the ground. The bands left a one-foot gap for the ground to swell into. This gave the quick-setting cement lining a chance to "take its set", develop its strength, and hold back the swelling ground.

The Coast Range Tunnel portion of the aqueduct consists of a 25-mile continuous tunnel, which was the longest in the world when completed — and another 3.5-mile tunnel. These two segments are linked by a multiple-pipe inverted siphon a half-mile in length across Alameda Creek Valley. Connections are now in place at the siphon to carry water from Alameda County sources of the San Francisco Water Department through the Hetch Hetchy Aqueduct.

From the geologists' point of view tunnel construction became one of the most fascinating stories of the time because of the discovery of fossil remains in the Tesla-Thomas section.

Among the discoveries were an ammonite (fossil shell) from the Mesozoic era with an estimated age of 33 million years, teeth of the three-toed horse, an elephant's

foreleg, and the skull of a Pliocene camel.

In one section (5,401 feet east of Valle shaft) granite was penetrated, the first time this rock had been encountered in this area of the Coast Range.

By 1932 the big tunnel project had been in progress for five years, and it had two more years to go. It became a year of crisis for Chief O'Shaughnessy, who had scheduled completion in 1932. He was blamed for the delay, although the Board of Supervisors had delayed commencement of the work for two years.

The Chief had been on the Hetch Hetchy job for 20 years, and time was taking its toll. He challenged members of the Board of Supervisors publicly, refused to find jobs for friends of important people, and showed some newspapermen out the door of his office.

Then the new City Charter of 1932 went into effect, creating a Public Utilities Commission responsible for operating Hetch Hetchy, the Water Department, and the Municipal Railway. O'Shaughnessy was no longer City Engineer. Lloyd T. McAfee, who had been Construction Engineer for the Mountain Division, then Assistant Chief Hetch Hetchy Engineer, was appointed Chief Engineer and Manager.

Mayor Rolph had gone to Sacramento as Governor of California — having been elected the previous year — and was no longer instantly available to the Chief.

O'Shaughnessy was given the title "Consulting Engineer" and an office in Water Department headquarters at 425 Mason Street in San Francisco. He was given no work to do and consulting with him was discouraged, according to recollections, but O'Shaughnessy had something important left — the loyalty of the men who had worked for him. McAfee, James H. Turner, and Max Bartell kept him involved in the project, taking him on inspection trips from time to time.

Turner, now retired and living in San Francisco, was later to become General Manager and Chief Engineer of the San Francisco Water Department and General Manager of Public Utilities.

The late Max Bartell, a hydraulic engineer who went to work on the Hetch Hetchy Project in 1908, was one of the talented men

January 5, 1934, date of the seventh and final "holing through" of the Coast Range Tunnel, longest in the world at that time, was an eventful day for "Chief" O'Shaughnessy (see page 23 of text). In front (left to right) are: George W. Pracy (standing), later to become the second General Manager and Chief Engineer of the Water Department; Edwin Eddy of the PUC; Louie Wheeler; and Edward J. Cahill, General Manager of Public Utilities. Seated on the platform, from left, are: Nelson A. Eckart, who was to become first General Manager and Chief Engineer of the Water Department; Les Stocker; M.M. O'Shaughnessy; Mayor Angelo Rossi; Lewis Byington, President of the PUC; T.W. Espey; and Supervisor J. Emmett Hayden.

largely responsible for its success. Among his remembered accomplishments was the human relations job with ranchers of the Modesto and Turlock Irrigation Districts. During the years after they finally gave their support to the Raker Act the Hetch Hetchy work found the Districts more or less in observer roles, watching the big project pass them by. Bartell, understanding their suspicion, spent a great deal of time in the San Joaquin Valley forming many valuable friendships, including a close relationship with Roy V. Meikle, Chief Engineer of the Turlock District, who died in 1975 at the age of 90, four years after retirement. Considering everything, San Francisco "has proven to be the best possible partner on the river," Meikle said in a 1971 interview by Gerald Perry of The Modesto Bee.

O'Shaughnessy was particularly interested in the date of the final "holing through" of the Coast Range Tunnel, and the big day came to pass on January 5, 1934.

City Hall's top leadership, including Mayor Angelo Rossi, was in the tunnel 2,500 feet below Crane Ridge, between the Mitchell and Mocho access shafts. Holing through is one of the most exciting ceremonials in the construction field. Only 12 inches of drilling remained — but for some reason Tunnel Foreman Pete Peterson delayed.

Then Project Engineer John "Buddy" Ryan arrived in the lighted ceremonial area with O'Shaughnessy in tow. He helped the 70-year-old man to the platform.

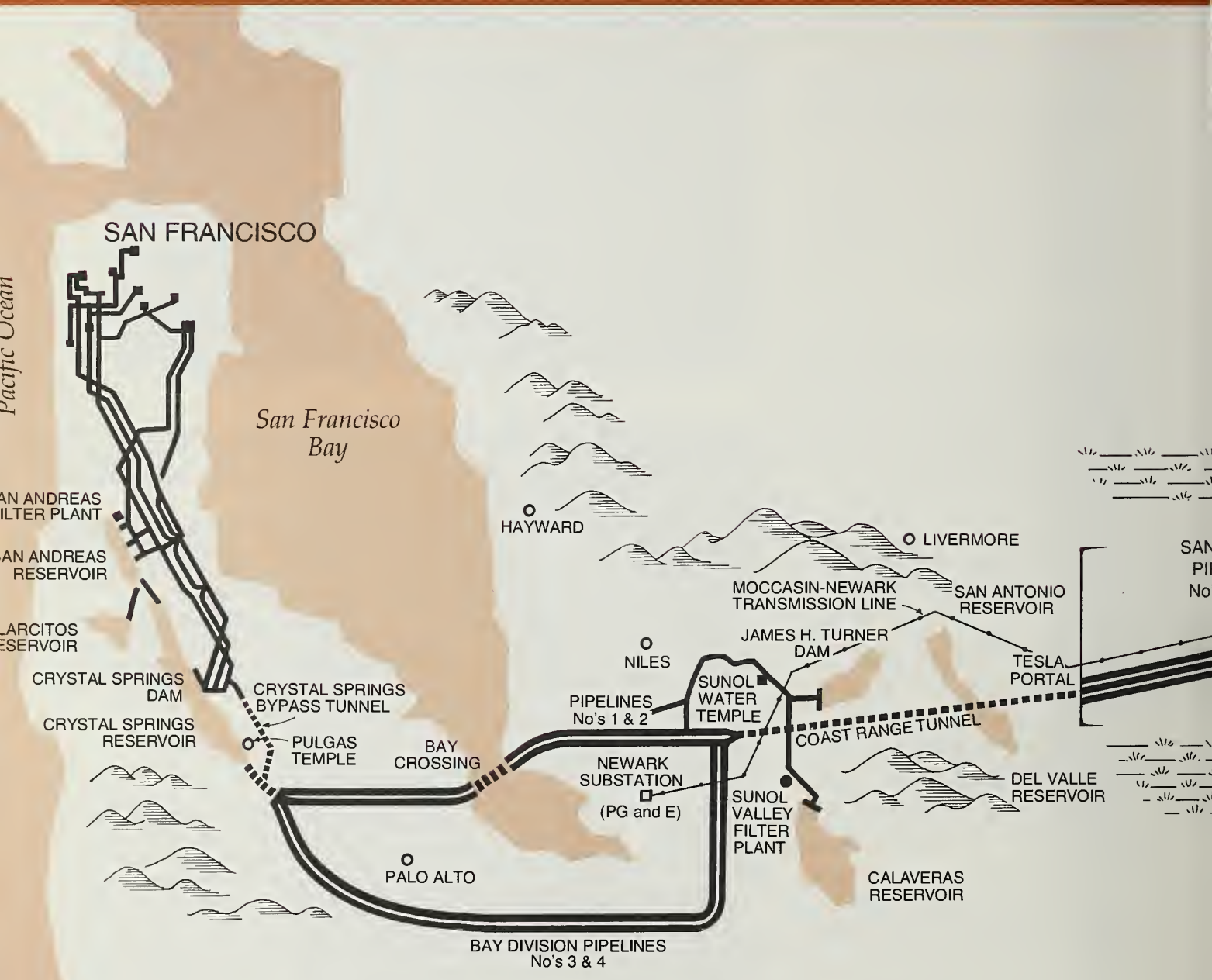
Peterson "pushed the hole through" from the other side, leaned through and asked O'Shaughnessy to shake hands with him. It was an emotional experience for "the Chief"

San Joaquin Pipelines

San Joaquin Pipeline No. 1 was completed in 1932, prepared to connect with the Coast Range Tunnel at its Tesla Portal seven miles south of Tracy. Hetch Hetchy had acquired a 100-foot right-of-way 47.5 miles across the San Joaquin Valley from the Oakdale Portal of the Foothill Tunnel. In it was space to lay four pipelines parallel to each other. It was also to contain Hetch Hetchy's power transmission line above.

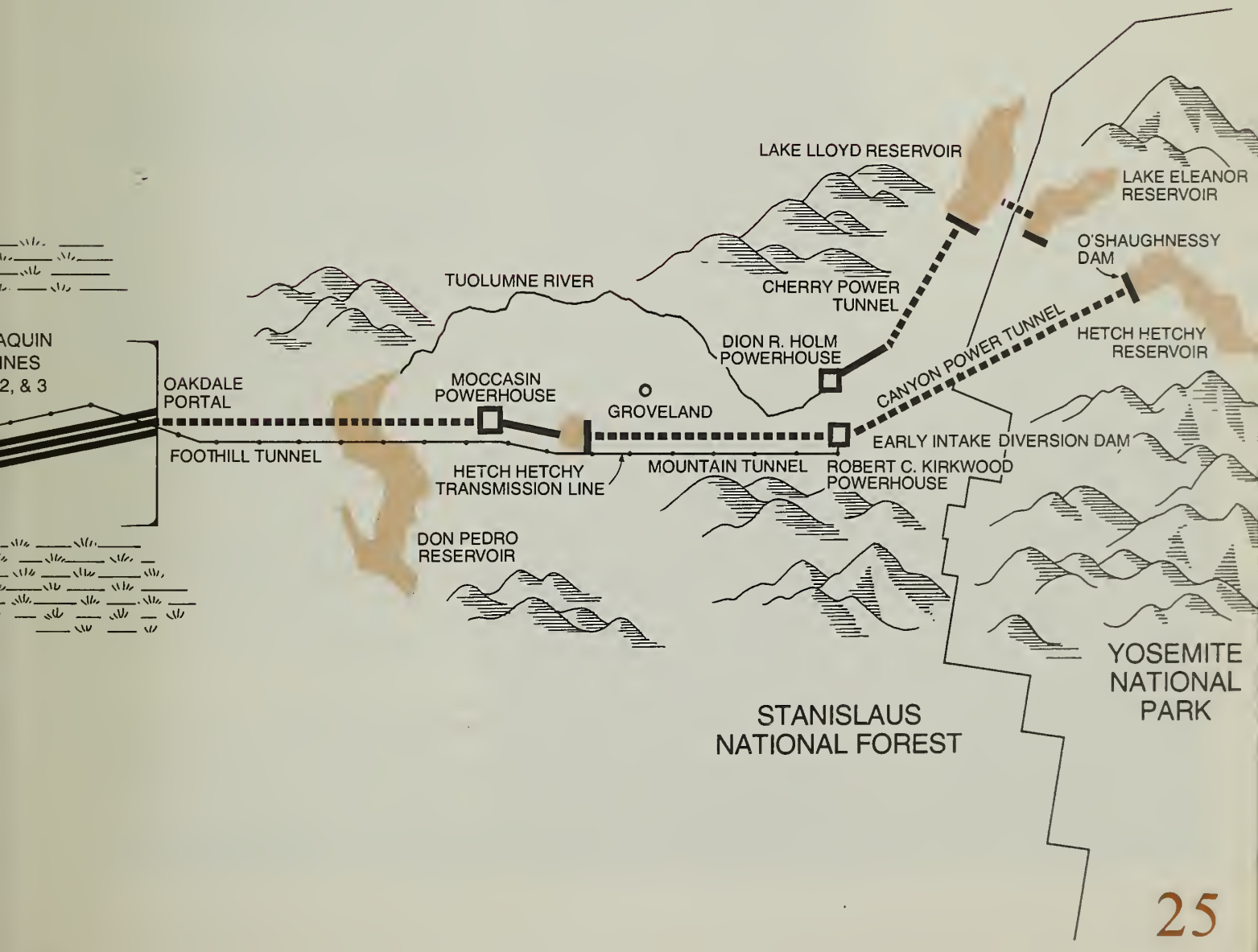
Since the engineers planned concurrently for the first three pipelines, we will depart

Carrying Water to San Francisco



. . . 148 miles by gravity

Also serves virtually all of San Mateo County residents and portions of Alameda and Santa Clara Counties. Present aqueduct capacity is 300 million gallons daily.



from the chronological format of the story to detail this project.

But first — the pipeline that was never used.

Corral Hollow Emergency Pipeline

The City of San Francisco was frantic in the autumn of 1930. It was in the grip of a bay area drought of four successive dry winters. What a beginning for the San Francisco Water Department, at this point only 8 months old! What a legacy from the Spring Valley Water Company! Its reservoirs were virtually empty, and the Department had 105,000 services that were accustomed to providing 52 million gallons of water daily to customers.

Three quick decisions were made. First, the Sunset Wells were sunk in the City's Sunset District and soon began producing 6 million gallons of water daily. Second, arrangements were made with the East Bay Municipal Utility District for a 12.5-mile emergency pipeline to deliver 30 million gallons daily, with a pumping station at San Lorenzo connecting with the City's Bay Division Pipeline No. 1 at Newark. The emergency supply was available on February 22, 1931, only 3.5 months after the contract was awarded. Most of the pipe was placed on the surface of the ground.

Third, fearing another dry winter, they turned to the Hetch Hetchy Aqueduct, only half a mountain and a few miles away.

Beginning in December, 1931, Hetch Hetchy constructed the 24-mile, 36-inch Corral Hollow pipeline, which would have a capacity of 45 million gallons daily.

(It is helpful at this point to remember the timing — and the significance — of the segmented construction . . . Bay Division Pipeline No. 1 was completed in 1925; the Mountain Tunnel and the Priest Reservoir-Moccasin facilities were ready in 1925; Foothill Tunnel was finished in early 1932).

Built under the direction of Hetch Hetchy's Max Bartell, the Corral Hollow pipeline would take the mountain water out of the Coast Range Tunnel at Thomas Shaft and pump it over the hills to Alameda West Portal where it would enter a completed portion of the Aqueduct.

The job was rushed to completion in just 6 months, with the pipe scarcely under the ground's surface so it could be salvaged easily later on.

But the rains came in the late winter, the reservoirs filled — and the Corral Hollow pipeline was never used. The pumps were never removed from packing cases, and, along with electrical equipment, they were sold. Ten years later the pipe brought good prices when sold to meet World War II shortages. Salvage recovered nearly all of the pipeline's cost of $951,000.

The first San Joaquin pipeline, costing $5 million, provides a daily capacity of 60 million gallons of water. Its diameter varies from 56 to 72 inches.

Pipeline No. 2 was completed in 1953. Costing $12.3 million, it brought aqueduct capacity to 140 million gallons daily. It is 61 inches in diameter.

Pipeline No. 3 is the largest of the three — 78 inches in diameter. Completed in 1968, it brought aqueduct capacity to 300 million gallons daily. Its cost was $19.5 million.

The fourth pipeline, to be built when demand requires, would bring daily capacity to 400 million gallons.

Placed 8 or 9 feet underground for most of the 47.5 miles, these pipelines, which carry the water under pressure, reach a point below sea level where they pass under the stream beds of the San Joaquin River and nearby Elliott Cut, both navigable streams. Elliott Cut is a man-made "slough", created for navigation purposes. Positioned 15 feet below the stream beds, the pipelines rest on concrete saddles supported by timber piles and are encased in reinforced concrete jackets.

There are automatic pressure relief valves on all three pipelines at the San Joaquin River crossing, prepared to discharge water into the river should excessive pressure develop, or in the event of pipeline breakage.

Bay Division Pipelines and Pulgas Tunnel

At last the Bay, and the remaining 25 miles of the Hetch Hetchy Aqueduct . . .

Four "Bay Division" pipelines pick up Hetch Hetchy water at the Irvington portal of the Coast Range Tunnel and bring it

across San Francisco Bay to the final tunnel of the Aqueduct. And although the construction of the pipelines covers a span of 50 years, this discussion will consider them concurrently.

Pipelines No. 1 and No. 2 are both 21 miles long and use the same right-of-way to cross the Bay at Dumbarton Strait to San Mateo County. No. 1 is 60 inches in diameter and was completed in 1925. No. 2 has 62 and 66-inch diameters and was completed in 1936.

No. 3 and No. 4, both 34 miles long, follow a second right-of-way around the southerly end of the Bay. Aside from creating certain service advantages, the separation of the routes of the two pairs guards against the loss of water from earthquake or damage from other causes.

The lines are made of riveted steel, welded steel, and steel cylinder reinforced and pre-stressed concrete. No. 3 is 72 to 78 inches in diameter. It was completed in 1956. No. 4, with a diameter ranging from 84 to 96 inches, is the largest of the four. It was completed in 1972.

In the navigable channel of the Bay No. 1 and No. 2 were placed in a trench as deep as 25 feet in the mud and 70 feet below water surface. They surface through a huge concrete caisson which forms the first pier of a bridge of 36 steel spans, each 105 feet long — all on concrete piers — and extending to San Mateo County at Ravenswood Point. The pipelines continue west beneath Redwood City into Pulgas Tunnel, 1-3/4 miles long and 10 feet in diameter. This tunnel brings the water from the Sierra through Pulgas Water Temple to Upper Crystal Springs Lake — the end of the trip, and gravity flow all the way. The contract for construction of Pulgas Tunnel was let on June 23, 1922, and it was ready for operation two years later.

Hetch Hetchy Arrives — Too Late for O'Shaughnessy

Even in retrospect the first flow of Sierra water into Upper Crystal Springs Lake is an exciting thought, and one would hope that it was properly celebrated on October 28, 1934, the day it happened. It has been described as a colossal event, broadcast nationwide by the radio network of the Columbia Broadcasting System.

Lewis F. Byington, President of the Public Utilities Commission, introduced the Hetch Hetchy builders. The Municipal Band played. There were addresses by Harold L. Ickes, Secretary of the Interior, and Mayor Angelo Rossi. Supervisor Jesse Colman paid tribute to Michael M. O'Shaughnessy, but the Chief was not there to hear it.

During the early morning of Friday, October 12, just 16 days before the first Hetch Hetchy water flowed, O'Shaughnessy complained of a pain over his heart. He died before a doctor arrived.

The Pulgas Water Temple, a plaster cast replica of the Sunol Water Temple in Alameda County, was rushed together for the welcome of Hetch Hetchy water. A few years later, with the help of Federal Public Works Administration funds it was made permanent with cast stone and concrete. Around the top of the temple and on a bronze plaque inside its well is the inscription from Isaiah, 43:20: "I give waters in the wilderness and rivers in the desert, to give drink to my people".

Back to O'Shaughnessy

Even as the initial phases of the Aqueduct were finished, the engineers finished the

Pulgas Temple, built at the terminus of the Hetch Hetchy Aqueduct in San Mateo County, was rushed together as a plaster cast replica of the Sunol Temple in Alameda County to observe the arrival of Hetch Hetchy water October 24, 1934. It later became a permanent structure.

plans and specifications for raising O'Shaughnessy Dam. San Francisco voters approved a $3.5 million bond issue in November, 1933, for this project. In January, 1935, bids were opened and the contract was awarded to the Transbay Construction Company with a low bid of $3,219,965.

At this time the nation was beginning to dig its way out of the great depression, and the renewed Hetch Hetchy activity was a blessing to Tuolumne County. San Francisco was offered a Federal grant under the National Relief Administration (NRA) for 30 percent of the cost of labor and materials. One condition of the grant was that no labor from the City could be hired until available unemployed Tuolumne men had been given work.

While Hetch Hetchy engineers were planning rehabilitation of the Hetch Hetchy Railroad, SERA (State Emergency Relief Act) inquired if some 600 men could be used to maintain City properties in the mountains. The City was delighted.

In March 696 men were working on the job of rebuilding tracks and roadbed. Though Hetch Hetchy engineers supervising the job were often dissatisfied with progress, it was accomplished.

This time the City did not operate the railroad. The Sierra Railway won the job with a low bid. Sierra began operating on the Hetch Hetchy road on May 13, 1935; and the City was satisfied with its performance.

The spirit of the original builders was on hand to greet the new crew when the O'Shaughnessy raising began. The foundation had been prepared 15 years earlier. It was wide enough to accommodate the addition — an 80-foot wide shelf on the downstream toe of the dam. Enlarging the dam was achieved by placing an addition against the downstream face of the dam to increase its thickness and rising to a new crest 85.5 feet higher. Many other details were taken care of to make the raising easier and less expensive.

Remember John H. "Buddy" Ryan, the engineer who made sure O'Shaughnessy was on hand for the final holing through of the Coast Range Tunnel?

As workmen were preparing to pour new concrete at the dam, Ryan removed the 1923 dedication plaque from its hollow

The ultimate O'Shaughnessy Dam, 312 feet above stream bed, was completed and dedicated October 16, 1938, bringing Hetch Hetchy Lake's capacity to 360,400 acre feet.

pedestal. Inside he carefully tucked the Chief's boots, black coat, and hard hat. Workmen sealed the pedestal, and Ryan watched as concrete buried it.

The enlargement of O'Shaughnessy Dam to its ultimate height of 312 feet above the stream bed was completed early in 1938. The contractor's heavy equipment was moved out by May. Clean-up followed, and then an extensive task of landscaping was undertaken. Within months it was difficult to believe that 400 men and many pieces of machinery had been busy there. The Superintendent of Yosemite National Park was summoned to inspect the dam area; and he was pleased with the results.

The big dam, which increased the storage capacity of Hetch Hetchy Lake to 360,400 acre feet, was dedicated October 16, 1938, with Mayor Angelo Rossi heading the program.

Harry E. Lloyd's association with Hetch Hetchy dated from Cherry River development. He became General Manager of Hetch Hetchy Water and Power in 1952.

The Cherry River Era

The job of raising O'Shaughnessy behind them, the engineers again packed their instruments and headed northwest 17 miles to Cherry River Valley and another major Hetch Hetchy project.

Surveys leading to the construction of Cherry Dam were undertaken and continued throughout the World War II years.

And the Public Utilities Commission turned to its partners in the Sierra.

San Francisco and the Modesto and Turlock Irrigation Districts were thrown together by the terms of the Raker Act, but it was about this time that the real partnership among them began to take shape. San Francisco needed to assure its water supply by additional mountain storage; and the Districts wanted additional storage for increasing irrigation needs. The three agencies were also looking ahead to the possibility of drought years, and they could use the revenue from increased electric power generation.

The Corps of Engineers, U.S. Army, became a fourth member of the partnership when it decided that the mountain projects could eliminate the periodic damage from floods along the lower Tuolumne River and the San Joaquin River.

In 1948 the four agencies signed cooperative agreements (the so-called "Third Agreement" and the "Army Agreement"). They provided:

1) San Francisco and the Districts would make certain modifications to existing facilities, construct new facilities, and operate them to reserve reservoir space for flood protection in accordance with Corps of Engineers regulations.

2) San Francisco would immediately construct Cherry Valley Dam.

3) The Districts would at a later time develop a larger reservoir on the lower Tuolumne River by building a new dam below old Don Pedro Dam.

4) Upon completion of the "New Don Pedro Dam" all flood control operations on the Tuolumne watershed would be transferred to the new storage facilities.

5) In return for flood control benefits the Federal government would pay $9 million toward construction of the $13 million Cherry Valley Dam and $5.4 million toward New Don Pedro.

6) To receive credit for 740,000 acre feet of exchange storage space San Francisco would help construct New Don Pedro.

Bringing water to the San Francisco Bay region was in truth a regional responsibility assumed under terms of the Raker Act. Now another regional aspect — a relationship with the irrigation districts — entered the picture; and Hetch Hetchy went to work on the Cherry River in earnest.

The man in charge was Harry E. Lloyd, who was to become Hetch Hetchy General Manager in 1952. Lloyd was a young engineer of 25 who had worked as a mining engineer in Grass Valley before joining Hetch Hetchy. He and "Ginger", a Hetch Hetchy saddle mare, became a familiar pair while Lloyd was surveying in Cherry River Valley.

Lloyd was hired by Carl Rankin, the construction engineer chosen by O'Shaughnessy to locate the route and construct the Hetch Hetchy Railroad. Rankin was also in charge of construction at O'Shaughnessy Dam, Mountain Tunnel, and other installations.

After retiring from a long and colorful career with Hetch Hetchy, Lloyd built another career and became Vice President of the engineering firm of DeLeuw Cather and Company.

He was succeeded on March 1, 1961, by Oral L. Moore, who at 39 years of age became the youngest engineer ever appointed General Manager of the Hetch

Hetchy System. A graduate of the University of Colorado, where he obtained his degree in civil engineering, Moore came to the job shortly after seven years' U.S. Navy service as a flyer. He would lead the Project through a series of major undertakings that would put the icing on the Hetch Hetchy cake.

Ten years before becoming General Manager, Moore directed the construction of Cherry Dam and its related power development. Preliminary work to Cherry included the construction of 26 miles of access roads through the rugged Sierra terrain which would carry heavy machinery to the dam site. In addition came a 10-mile power line from the old Early Intake Powerhouse and a 17-foot diversion tunnel a quarter of a mile long to carry water around the construction site. The tunnel, when later made permanent, would become one of two dam outlets. The other is a 6-mile power tunnel to Dion R. Holm Powerhouse on Cherry River, near the Tuolumne confluence.

Cherry Dam was designed by Wesley F. Getts who came to Hetch Hetchy with several engineering achievements behind him. As a field engineer for Bethlehem Steel Company from 1933 to 1935 he helped engineer the construction of Golden Gate Bridge towers and the East Bay crossing of the San Francisco-Oakland Bay Bridge. He was Assistant Engineer for the Golden Gate Bridge and Highway District from 1935 to 1937, and was responsible for construction of cables and deck of the bridge.

At 330 feet Cherry Dam was the highest earth and rock fill dam in the country at the time of its completion in 1956. It is a half-mile long and a quarter-mile thick at the widest point.

When the dam was finished a beautiful new lake formed in Cherry Valley. The next year the Board of Supervisors, on motion by Supervisor John Jay Ferdon, named the lake in honor of Harry Lloyd. Functioning in partnership with Lake Eleanor, it would become part of an effective power generating unit.

Oral L. Moore, who became Hetch Hetchy General Manager March 1, 1961, was in charge of construction of Cherry Dam. He later initiated a series of agreements that have been the basis of San Francisco's partnership on the Tuolumne River with the Modesto and Turlock Irrigation Districts. In photo at upper right is Wesley F. Getts, designer of Cherry Dam, who is well known for his engineering contributions to the Golden Gate Bridge and the San Francisco-Oakland Bay Bridge.

1960, A Big Year

While work on Cherry Dam was winding down, Hetch Hetchy started driving a 5,900-foot tunnel through the ridge separating Lloyd and Eleanor. This tunnel enables water from Eleanor's 79 square mile watershed to supplement storage from Lake Lloyd's 114 square miles of watershed.

The impounded water does not contribute directly to San Francisco's domestic water supply, except in case of drought or other emergency. It is used for power generation at Holm Powerhouse and then flows downstream to meet irrigation priorities

under the Raker Act, thereby preserving storage in Hetch Hetchy Lake for the City's domestic supply.

The Lloyd-Eleanor tunnel went into service in 1960.

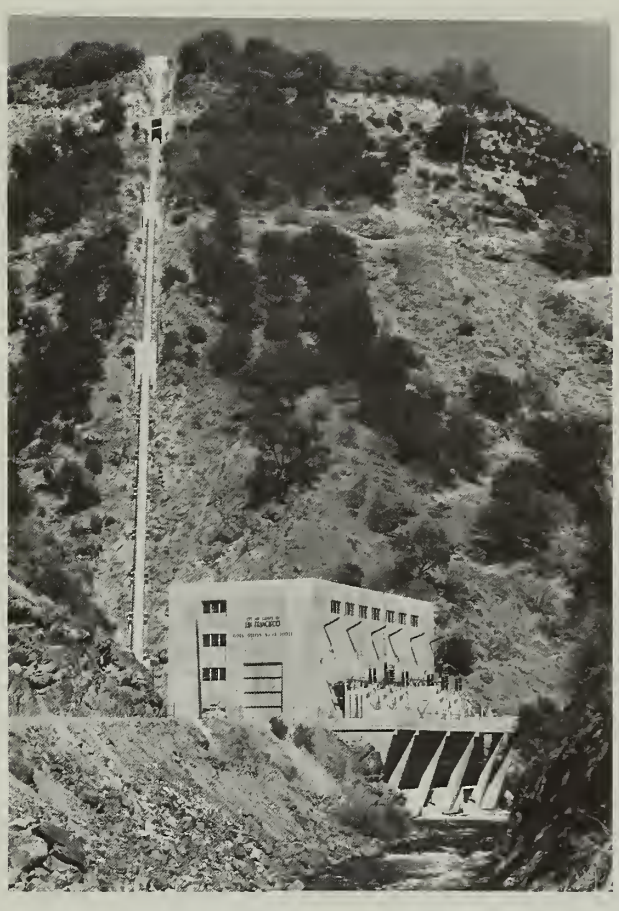
Dion R. Holm Powerhouse

Largest power plant in the Hetch Hetchy system, Dion R. Holm Powerhouse went on the line in 1960. Each of its two vertical-shaft, turbine-driven generators are rated at 67,500 kilowatts; and voltage is stepped up to 230,000 volts for transmitting power a mile and a half to Intake Switchyard.

The water operating Holm leaves Cherry Dam through a 6-mile pressure tunnel. Mostly unlined, it was bored through granite in 12 by 12.5-foot horseshoe shape. The tunnel has a 400-foot tall surge shaft and a rock trap near the downstream portal. Then the water enters a single, steel pipe penstock 6700 feet long. The penstock, 7.5 feet in diameter at the top, tapers to 5 feet at the powerhouse. It drops the water 2100 vertical feet; and to sustain the high pressure the pipe is fabricated from steel plate which increases in thickness from 3/4 inch at the top to 2 1/2 inches at the bottom of the penstock.

Hetch Hetchy invested $25 million in the plant, tunnel, penstock, and all equipment except transmission lines.

The plant was re-dedicated August 25, 1967, in memory of the late former City Attorney, Dion R. Holm, who served as the system's counsel during its early operating years. He was a devoted advocate for Hetch Hetchy. By nature a gentle man, he became a tiger at the slightest hint of trouble.



Dion R. Holm Powerhouse.

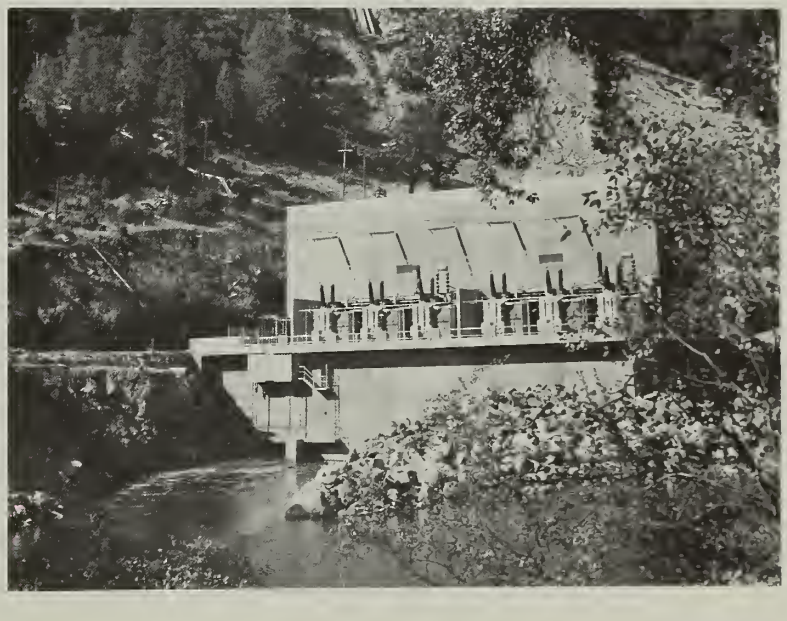
Canyon Tunnel and Robert C. Kirkwood Powerhouse

With completion of the 11-mile Canyon Tunnel in 1965 the Hetch Hetchy Aqueduct was to have a new beginning.

The water in the aqueduct would leave the base of O'Shaughnessy Dam in a 9-foot steel pipe encased in concrete. Passing beneath the Tuolumne River, it enters the Canyon Power Tunnel.

Driven by Clancy O'Dell Construction

Robert C. Kirkwood Powerhouse.



Company through a solid granite mountain along the north side of the river, the pressure tunnel is capable of carrying 550 million gallons of water daily at the pressure of average reservoir elevation. The tunnel is unlined except in a few places where ground conditions required concrete lining, and at the portals where steel lining is utilized. It slopes 10.5 feet a mile, and the horseshoe-shaped unlined section measures 14 by 14.5 feet high. Its cost was $11 million.

Water from Canyon Tunnel enters a 1600-foot, $2.3 million penstock for a vertical drop of 1100 feet to turn two vertical shaft turbines, each in turn driving a water-cooled generator rated at 33,750 kilowatts at 13,800 volts. Power is stepped up to 230,000 volts through transformers and transmitted three quarters of a mile downstream to Intake Switchyard, where it joins power from the Holm Powerhouse for transmission through the system.

Built at a cost of $5,643,000, it went on the line in 1967. Dedicated on August 25th of that year, it was named in memory of the late Robert C. Kirkwood who had been a State Assemblyman and State Controller before being appointed General Manager of Public Utilities in 1959. Kirkwood died unexpectedly in 1964, and was succeeded in that office by James Kennedy Carr who resigned as Under Secretary of the Interior in order to take the position.

Both the Kirkwood and Holm plants are operated by remote control from Moccasin Powerhouse 20 miles away. By push-button operation generating units are started and stopped, speed and voltage are adjusted, readings taken, and needed switching accomplished.

New Moccasin Powerhouse

Rated at 90,000 kilowatts, New Moccasin, Hetch Hetchy's newest powerhouse, was placed in service in 1969. The installation is of the outdoor type, with two generators of 45,000 kilowatt capacity each. It is adjacent to the old plant, replaced after 44 years of constant service, uses the same penstocks, and with its two generators brings in $250,000 more revenue annually than the old plant produced with four generators.

Now known as just Moccasin Powerhouse, the facility was built at a cost of $8,830,000 — significantly higher than the $2.4 million paid for its predecessor. There is much more sophistication in the new one, however, and fewer man hours are required to operate and maintain it.

New Moccasin Powerhouse went on the line in 1969.

Don Pedro Dam

Following his appointment as Hetch Hetchy General Manager in 1961, Oral L. Moore immediately initiated discussions with the Modesto and Turlock Irrigation Districts, looking toward construction of "New Don Pedro Dam", reservoir, and powerhouse. After four difficult years' negotiations with the California Department of Fish and Game the project was approved by the Federal Power Commission.

The Don Pedro relationship was to become of immeasurable value to San Francisco. The storage created for the City would virtually double the amount of water that could be diverted from the Tuolumne River for the Bay area.

Hetch Hetchy would be credited with 740,000 acre feet of exchange water storage space in the new reservoir, increasing City high mountain storage to 1,395,000 acre feet — enough to increase diversions to San Francisco by 190 million gallons of water daily. The consequent total daily capacity of 400 million gallons will provide a supply of water adequate to meet San Francisco's domestic needs until well into the next century.

The Public Utilities Commission invested $45 million to finance Hetch Hetchy's share of the $100 million New Don Pedro project. The Army's Corps of Engineers would pay $5.4 million for flood control benefits, and the Districts would pay the rest. The Public Utilities Commission's funds came from the $11.5 million water system bond issue approved by San Francisco voters in 1961. At that time it was the biggest bond issue in the City's history, and it passed with more than 90 percent of the votes.

New Don Pedro — now just "Don Pedro" — was built about a mile and a half downstream on the Tuolumne below the old dam. Its construction, begun in 1967, had many of the fantastic characteristics of Hetch Hetchy construction. A massive rockfill dam rose to 580 feet in height, inundating the old dam upstream to a depth of 200 feet. Don Pedro created a lake 24 miles long, reaching to the doorstep of Moccasin, and possessing a shoreline of 165 miles. The reservoir, known as Lake Don Pedro, has a storage capacity of about 2 million acre feet.

These three photos, covering a 6-year span, were made from the same point, looking east up the Tuolumne River canyon. Top: the settlement of Jacksonville on May 29, 1969; middle: the settlement is gone in preparation for the Tuolulmne waters that will be backed up by the new Don Pedro Dam some 20 miles downstream; bottom: Lake Don Pedro is full. State route 120 was moved from the north to the south side of the canyon.

Engineered by the Bechtel Corporation and built by Guy F. Atkinson Company, Don Pedro construction included a 10-mile haul road to carry tailings — gravel dug up from early day gold dredging and left in huge piles in Tuolumne River bed — to the dam site. Removal of the tailings restored — even added to — the river's beauty, and gave it a new recreation potential. And the material made excellent fill.

Hetch Hetchy builders 45 years earlier would have been fascinated by the technology associated with the Don Pedro Project. The massive machinery was mind-boggling. Huge K-W Dart "bottom dump wagons" averaged about 45 miles an hour day and night on the haul road, each carrying 75 cubic yards of fill. Computers helped make decisions. For example, the computer said a computerized sprinkling system would be the best way for keeping dust down on the haul road. Many visitors were surprised later by the man-made "rains" on the excellent road which was later incorporated into the county road system.

Some 3,000 people gathered at Don Pedro Dam during the balmy morning of May 22, 1971, for the dedication of the dam. The program was highlighted by the speech of San Francisco Mayor Joseph L. Alioto, who spoke on one of his favorite subjects — "invisible political boundaries, rendered meaningless by cooperative achievements like this". A well-rehearsed high school band played; and the throng was treated to generous portions of barbecued beef prepared by the Turlock Irrigation District.

Don Pedro construction awakened a lot of gold rush history — places and things born in the frenzy of the era, only to fade from memory as rich gold strikes were depleted.

Readers of the Modesto Bee were treated to detailed accounts of the dramatic Don Pedro project, and they received a bonus of well researched historical features by reporters Thorne Gray and Gerald Perry.

Who was Don Pedro?

A Frenchman, named Pierre Sainsevain. In early California anyone who owned a rancho gained the title "Don". Pierre in French translates to Pedro in Spanish.

"Don Pedro" was active in a half-dozen business enterprises after his arrival in San Francisco in 1836 aboard a ship from Bordeaux, France. Don Pedro Bar on the Tuolumne River was named after him; and it became one of the most famous gold mining towns, reportedly the site of a rich strike.

Thorne Gray wrote the story of Don Pedro, probably for the first time, from information he obtained from Colton Hall Museum in Monterey, and from Wine Institute files in San Francisco. ("Don Pedro" Sainsevain and his brother, Jean Louis, became vintners of repute).

Gerald Perry wrote about the Eagle-Shawmut Mine, once Tuolumne County's biggest gold mine. It opened in the 1860s on Woods Creek at the foot of Shawmut Grade, and its thunderous stamping mill could be heard for miles. It operated until 1926, and was reopened in 1938. The last owners, H.G. Miller and George W. Clemson, removed $2 million in gold between 1938 and 1947 when it was closed for good.

Machinery and equipment were dismantled and sold. Tunnels and shafts — some 2,450 feet deep — were sealed forever with dynamite blasts.

Lake Don Pedro waters covered the scene in the spring of 1971.

Also beneath the lake's waters is the site of the town of Jacksonville, one of the first towns to grow in the Tuolumne gold fields. Dating back to 1849, Jacksonville, downstream a few miles from Moccasin, flourished because of the traffic to and from the gold fields and mines by providing hotels, stage stops, and natural river crossings.

The new $100 million Don Pedro Dam is shown under construction in November, 1969, in the top photo. The lower photo shows the results — a lake 24 miles long with a shoreline of 165 miles, and storing 2 million acre feet of water. These waters, administered by the Modesto and Turlock Irrigation Districts, enable the fertile valley lands to feed a good share of the nation.

Modesto Irrigation District photo.

Power

The Raker Act prohibits San Francisco from selling Hetch Hetchy electrical energy directly or indirectly to any private corporation or individual for resale. The intent was to prevent exploitation of the public lands involved for possible private gain. Interpretation of this provision of the Act created continuing controversy for 20 years, until it was settled in court in 1945.

Under the Raker Act San Francisco is required to "sell or supply" at cost that power in excess of its own needs to the Modesto and Turlock Irrigation Districts, or municipalities therein, for pumping and municipal purposes. Thereafter any surplus may be sold for commercial consumption.

The City owns no distribution system. Originally plans were to bring Hetch Hetchy power into San Francisco for distribution through a municipally owned system advocated by the City Charter. Between 1927 and 1941, however, a series of bond issue proposals to finance acquisition of Pacific Gas and Electric Company facilities were submitted to voters. The bond propositions were soundly defeated at six different elections.

Contracts for disposal of Hetch Hetchy power were finally negotiated and approved by the Secretary of the Interior, the California Public Utilities Commission, and the United States District Court in 1945.

The contracts provide for Pacific Gas and Electric to pick up power from the City's transmission lines at Newark in Alameda County and move it through its system for delivery to service points. The City pays cash for these services. Power is delivered directly from Hetch Hetchy transmission lines to substations of the Modesto and Turlock Irrigation Districts.

Hetch Hetchy's three power plants generate approximately 2 billion kilowatt hours of energy a year; and gross revenues generally average about $14 million.

A spectacular sight — and sound — in early summer is Rancheria Falls where it empties into Hetch Hetchy Lake.

Power Transmission

Two high voltage transmission systems, normally operated independently of each other, carry Hetch Hetchy power from powerhouses to points of delivery.

Power from Dion R. Holm and Robert C. Kirkwood powerhouses leaves Intake Switchyard on a steel tower transmission line of 230,000 volts, double circuit, to Moccasin and then to Warnerville Substation near Oakdale, a distance of 48 miles. Here voltage is reduced to 115,000 for further transmission over a 12.5-mile line to Oakdale Substation of the Turlock Irrigation District and Station "J" of the Modesto Irrigation District. Warnerville also serves as a point of interconnection with the 230,000-volt system of P.G. and E.

The 115,000-volt transmission line from Moccasin Powerhouse extends to Newark in southwest Alameda County where it interconnects with the Newark Substation of P.G. and E. This line generally follows the same right-of-way as the Hetch Hetchy Aqueduct as far as Tesla near Tracy.

Built in 1924 and 1925, the line covers 98.5 miles. With two 3-phase circuits (six wires), the wires are supported by 506 steel towers, most of which are 97 feet high. At the crossing of the San Joaquin River special 208-foot towers are used. Along the way each circuit of the Moccasin-Newark line is connected with taps to substations of the two irrigation districts.

Hetch Hetchy General Managers

Michael M. O'Shaughnessy	1912-1932
Lloyd T. McAfee	1932-1942
James H. Turner	1942-1945
Axel O. Olson	1945-1952
Harry E. Lloyd	1952-1961
Oral L. Moore	1961

Hetch Hetchy's Senior Staff

Oral L. Moore	General Manager
Robert L. Stein	Assistant General Manager
Patrick J. Phillips	Principal Engineer
Robert E. Collins	Senior Electrical Engineer
Theodore L. Chung	Senior Electrical Engineer
Raymond G. Miller	Senior Civil Engineer
Ronald Ciraulo	Senior Civil Engineer
Finn Haaskjold	Mechanical Engineer
Jack E. O'Rourke	Senior Architect
John K. Kellogg	Construction Engineer
Raymond A. Protti	Superintendent of Power and Plant Transit Power Division

Moccasin Division

Helmer R. Adler	Superintendent of Operations
Dean Coffey	Superintendent of Maintenance and Repair
Alton L. Walter	Mechanical Shop and Equipment Superintendent
Harold W. Eaton	Mechanical Shop Supervisor
Gary L. Hislop	Assistant Superintendent, Maintenance and Repair
Frank E. Cummings	Powerhouse Superintendent
Edward Krejcik	Powerhouse Superintendent

Transit Power Division

Richard Thompson	Transit Line Supervisor II
John V. Hope	Supervisor of Motive Power

San Francisco Water Department

Water to Grow By

In the beginning it was clear that San Francisco, once Yerba Buena, had a built-in water problem. Located on the tip of a 50-mile long peninsula, it has salt water on three sides.

Franciscan missionaries selected a small stream as the source of water for Mission Saint Francis de Assisi, later to be called Mission Dolores.

From then on the problem became more complicated as the population grew. San Franciscans with no well or spring on their property had to depend upon either the small water companies trying to succeed, or door-to-door peddlers. Some of the latter obtained their water from boats that ferried it across the Bay from Sausalito. There were purveyors who had regular routes, just like milk peddlers — and stories have it that water sometimes sold for as high as a dollar in gold per bucket.

Where the Mountain Lake Water Company failed in 1851 in attempts to make effective use of water from Mountain Lake and Lobos Creek in the Richmond District and the Presidio of San Francisco, the San Francisco Water Works, established in 1857, succeeded. Water was carried five miles by flume and a tunnel through Fort Point to Black Point at the foot of Van Ness Avenue. A pumping station forced the water into the Francisco and Lombard Reservoirs which are still in use on Russian Hill.

In 1860 Spring Valley Water Works was organized under a charter from the State Legislature; and it laid a few mains from a spring located at Washington and Mason Streets, the site of the present Cable Car Barn of the Municipal Railway.

Not enough water! That would be a familiar refrain in San Francisco for the next 75 years.

Spring Valley turned to San Mateo County and began developing what is essentially the beginning of today's Peninsula System of the San Francisco Water Department, the only section of the Bay area that is substantially the same today as then. Actually, looking at old photos will convince you that it is more beautiful today.

Work began on Pilarcitos Dam in 1864, and it was completed in 1867. But first Spring Valley, which took over San Francisco Water Works in 1865, brought the first water to the City from a small dam on San Mateo's Pilarcitos Creek to its Brannan Street Reservoir through a 32-mile redwood flume on July 4, 1862. (The new Laguna Honda Reservoir would not be ready until August).

It was a July 4th that was. San Francisco's 80,000 people were in a mood to celebrate. The telegraph had carried the news of Union victories at Mechanicsville and Malvern Hill (a bitter struggle was underway at Chickahominy). President Abraham Lincoln had just signed a bill for a railroad from the Missouri River to the Pacific Ocean. Beginning on the 4th, the Market Street Steam Railroad would run from "San Francisco" to The Willows, a "respectable resort" with pleasant music and good beer, at 18th and Valencia Streets. A new song, "Aunt Dinah's Quilting Party", was on sale at the music houses.

The steamer Golden Gate had brought in a cargo of oranges from Acapulco, and they were wholesaling for $35 a thousand. The Peter Clinton from Glasgow entered the harbor with 554 casks of ale and 20 puncheons of fine Scotch Whiskey.

There was to be a parade from Washington Square, around and about, to the Metropolitan Theater on Montgomery Street. Orator Robert C. Rogers "twisted the British lion's tail". W.H. Tiffany, well known for the feat, read the Declaration of Independence; and Frank Soulé, poet of the day, read 184 long lines of original patriotic verse.

Aside from their patriotic fervor, San Franciscans were celebrating a major achievement. Spring Valley had lived up to its pro-

This scene along Pilarcitos Creek could have inspired William Cullen Bryant. Hard to believe it is within 25 miles of a metropolitan area of more than a million people.

mise to bring in water from far off Pilarcitos in time for the great celebration. It arrived shortly after midnight, as duly noted in the five principal daily newspapers — the Alta California, Call, Herald, Bulletin, and Journal.

Other Peninsula developments were completed fairly rapidly — San Andreas Dam in 1868, Upper Crystal Springs Dam in 1878, and Lake Merced with a pumping plant near the present Fleishhacker Zoo came into service in 1878.

Lower Crystal Springs Dam across San Mateo Creek, built between 1887 and 1890, completed development of all economically practicable reservoir sites on the Peninsula. All subsequent development of the company's system was in the Alameda Creek area of Alameda and Santa Clara Counties.

As the new century approached, San Franciscans were desperate for an adequate and reliable water supply; but it was a long way off. By the 1870's angry residents were demanding a municipally owned system; and the Board of Supervisors authorized several investigations of outside sources.

A special study committee, headed by T.R. Scowden, a City engineer, recommended on April 19, 1875, that San Francisco buy a Calaveras reservoir site on a branch of Alameda Creek in Alameda and Santa Clara Counties as the beginning of a future water supply. But the Spring Valley company effectively blocked this threat of competition by promptly purchasing the land and water rights for itself. It was not until 1913, however, that the company began building this reservoir.

Although the principle of municipal ownership was in limbo for a while, the search for water went on.

Buying Spring Valley

While the search was on San Franciscans, continually irritated by Spring Valley's poor service, were trying to buy the company out. The first attempt was as early as 1873, and it failed. But it only sharpened the City's desire for its own system. Soon the City's eyes were on the Sierra.

According to documents of the times, the water situation progressed from bad to worse; and Spring Valley's limited resources could not deal with the demand.

Hetch Hetchy construction moved steadily forward, with wise engineers moving forward with the first Bay crossing pipeline when building in the Sierra was still in its infancy. It was rushed to completion in 1925 during one of the area's water famines. It was immediately leased to Spring Valley and went into service when the company had only a 70-day supply in Peninsula storage.

In the election of January 14, 1910, a $45 million bond issue for construction of the Hetch Hetchy system was approved by the voters. An alternative proposal of $23 million for the development of Hetch Hetchy and $35 million to buy the Spring Valley system also appeared on the ballot. It failed by a narrow margin.

There were to be four more attempts to purchase Spring Valley. Bond issues failed to get the required two-thirds margin in 1915, 1921, and 1927. Money and influence were used effectively by Spring Valley, and the Board of Supervisors was dealing with a fickle public which was disinterested when water was abundant, and hard to organize in dry seasons. However slowly, the move for municipal ownership gained strength. Spring Valley became known as "the impudent monopoly".

But the Hetch Hetchy message was getting across, providing sufficient inspiration to make the election of May, 1928, a different story. The vote on a $41 million bond issue to buy Spring Valley carried 4 to 1.

Now the City owned 62,612 acres of water supply properties in four counties:

	Acres
San Francisco	968
San Mateo	23,775
Alameda	24,267
Santa Clara	13,602
Total	62,612

There were four impounding reservoirs, one reservoir in the City (Lake Merced) from which percolating waters (filtered when passing through earth) were once pumped, the Pleasanton well system at the lower end of Livermore Valley, and the Sunol gravel beds from which percolating waters are still drawn.

For its $41 million the City also received:

- All riparian and other rights necessary to protect the privilege of diverting and utilizing the waters.
- A total of 111 miles of main aqueducts, consisting of pipelines, conduits, and tunnels carrying water to San Francisco, and pumping stations on the aqueducts.
- All necessary rights-of-way for aqueducts, roads, power lines, etc.
- A distribution system consisting of 20 holding reservoirs and tanks of a combined capacity of 135 million gallons, 750 miles of pipe, and all related pumping stations.
- More than 100,000 water services.

11-35 Bank of Italy No. 11-35
SAVINGS COMMERCIAL TRUST
HEAD OFFICE
MARKET, POWELL AND EDDY STREETS
SAN FRANCISCO, CAL. March 3, 1930
PAY TO THE ORDER OF SPRING VALLEY WATER COMPANY * * * * * * * * * * * * $39,962,606.51
THIRTY NINE MILLION NINE HUNDRED SIXTY TWO THOUSAND SIX HUNDRED SIX & 51/100 DOLLARS
DUNCAN MATHESON, TREASURER
CITY & COUNTY OF SAN FRANCISCO
Duncan Matheson

The People's System in Operation

The City began operating its own system at 12 noon on March 3, 1930. The San Francisco Water Department has been self-supporting, paying its own operating and improvement costs ever since. Until it was hit by the escalation and inflation of the 1970s, the Department was still selling water at less than the Spring Valley prices of 1930.

Nelson A. Eckart was the Water Department's first General Manager and Chief Engineer, succeeded January 1, 1949, by George W. Pracy. Six others have been in the top chair since then, including Eugene J. Kelleher, its present occupant.

In the beginning customers were using an average of 52 million gallons of water daily — 49 million in the City and 3 million in the suburbs. Today, still mindful of 1977-78 water rationing, they are using an average of 196 million gallons daily — 78 million in the City and 118 million in suburban areas.

Water Department operations are now in two divisions — the Suburban Division, which includes the Alameda and Peninsula systems and the City Distribution Division. Formerly separate divisions, the Alameda and Peninsula systems were combined and placed under a Suburban Division Manager in 1977.

Pilarcitos Lake from the air. Its dam was completed in 1867. But a small dam built upstream enabled the Spring Valley Water Company to bring water through a 32-mile flume to San Francisco in time for its Fourth of July celebration in 1862.

Alameda System

The Alameda system includes three water-producing units within the drainage area of Alameda Creek, located in the Coast Range Mountains of the East Bay.

Principal sources are Calaveras and San Antonio reservoirs, which are supplemented by underground water from the Sunol Valley infiltration galleries. The Pleasanton well field is no longer used.

Calaveras Reservoir

Located about nine miles south of the town of Sunol, this reservoir was created by an earth and rock fill dam completed in 1925 by the Spring Valley Water Company. At that time the dam was the highest of its kind in the world.

Hetch Hetchy Chief Engineer, M.M. O'Shaughnessy "bird dogged" it all the way. It was outside his authority, but he did not like the way Spring Valley was building it. In 1975 the dam was strengthened to meet earthquake standards — a $1.6 million project funded by the 1972 water bond program.

Calaveras lies in both Alameda and Santa Clara Counties, and stores runoff from 100 square miles of Calaveras Creek and Arroyo Honda watershed, originating with Smith and Isabel Creeks on the slopes of Mt. Hamilton. Drainage from an additional 35 square miles of Upper Alameda Creek is diverted into the reservoir through a 9,700-foot tunnel.

Water can be released through a two-branch outlet tunnel to: (1) flow down to the Sunol infiltration galleries and then to the 44-inch Calaveras pipeline, (2) the Hetch Hetchy Aqueduct through a connection at the Alameda Creek siphon, (3) to the aqueduct through the Sunol Valley Filtration Plant, or (4) to San Antonio Lake for storage to conserve local runoff.

San Antonio Reservoir

About three miles southeast of Sunol, this reservoir was created by James H. Turner Dam, a compacted earth-fill structure 195 feet high, 2,160 feet long, and 1,075 feet wide at the base. Completed in 1965 at a cost of $9.4 million, the dam was named after James H. Turner, former General Manager of Public Utilities and Water Department General Manager and Chief Engineer. He is now in retirement.

Constructed on San Antonio Creek, a tributary of Alameda Creek, San Antonio has a capacity of 16.5 billion gallons. It stores runoff from a 40-square mile watershed and yields an average annual supply amounting to 5 million gallons a day.

Sunol Galleries (and Pleasanton Wells)

Comparatively, these were relatively insignificant water producers — and the Pleasanton wells are no longer in use — but developing them was an interesting example of water engineering.

Deep gravel beds lie beneath the surface of both the Livermore and Sunol Valleys; and it was Herman Schussler, German born engineer who came to the United States from Switzerland, who decided as Chief Engineer for the Spring Valley Water Company, that they were good water sources.

A natural basin area at the lower end of the 35 square-mile Livermore Valley is the scene of 100 wells, ranging in depth from 200 to 734 feet. Drilling was started by Spring Valley in 1898, and in 1909 a 30-inch pipe was installed to collect water pumped from the wells.

During the early days the water table in the two valleys was drawn to an undesirably low level by Spring Valley. Since then the San Francisco Water Department has suspended use of the wells, and by drawing reasonable amounts of water from the valleys is endeavoring to restore the water table level. Hopefully, the wells will sustain emergency use some day.

Sunol Valley is a beautiful valley of 1,300 acres at the upper entrance to Niles Canyon through which the entire drainage of 600 square miles of Alameda Creek must pass on its way to San Francisco Bay. A low dam (Sunol Dam) at the canyon entrance backs up the water in the gravels. An 8,985-foot concrete tunnel (or "filter gallery") pierced with screened brass pipes, and tapped by 36-inch perforated concrete pipes, drains water from the gravel.

Water from the filter gallery and the well

Sunol Dam was built near the turn of the century to back up water that was then collected after draining through the gravel sub-surface of Sunol Valley.

field merged at a gathering basin near the Sunol headquarters for the Alameda system, an important enough achievement that Spring Valley hired Willis Polk, a respected San Francisco architect, to design a suitable memorial. The result was the lovely Sunol Water Temple which reflects the grace found in the style of centuries old Greek architecture. It was erected in 1910.

Polk was the architect, also, for Spring Valley's new headquarters building at 425 Mason Street, San Francisco, which was completed in 1910. It still serves as headquarters for the San Francisco Water Department. The 7-story reinforced concrete structure has the foundation, walls, and columns necessary for two more stories. Polk retained painter Maynard Dixon who painted the "Spring Valley Mural" on the wall above the elevators on the north side of the building's first floor. Polk selected Miss Lucille Schoenfeld, a talented San Francisco sculptor, to design the clock case for the clock that still tells time for the Water Department.

Peninsula System

Lake Pilarcitos

Three San Mateo County lakes serve as storage reservoirs for the Water Department — Pilarcitos, San Andreas, and Crystal Springs.

The dam creating Lake Pilarcitos is the oldest on the Peninsula, completed in 1867 and raised to its present height in 1874. It is located 11 miles south of San Francisco on Pilarcitos Creek, which empties into the Pacific at Half Moon Bay. The dam was rehabilitated in 1972 to meet earthquake standards of the State Division of Safety of Dams.

A brick tunnel through the ridge to the east and a pipeline carry Pilarcitos water to San Andreas Lake. Being in an area of high precipitation, Pilarcitos often receives more water than its 1 billion gallon capacity can hold. The extra water is transferred to San Andreas. Water from Pilarcitos is also collected by Stone Dam (built in 1872) two miles downstream and diverted by brick tunnel and pipeline to Crystal Springs Lake.

San Andreas Lake

Located 2.5 miles east of Pilarcitos on a branch of San Mateo Creek, it has 4.4 square miles of watershed, but can be supplemented by 2.5 square miles of contributing areas by diversion.

San Andreas, in the valley just west of the Junipero Serra Freeway (Interstate 280) is the first lake seen while traveling south from San Francisco.

Initially completed in 1869, built higher in 1875, and brought to its present 105 feet in 1928, San Andreas Dam proved its sturdiness during the 1906 earthquake. The San Andreas Fault lies directly beneath the easterly abutment of the dam. Though there was movement of about 8 feet along the rift at this point, there was no damage to the dam.

Crystal Springs Lake

Terminal point for the Hetch Hetchy Aqueduct, this beautiful lake is the Peninsula's most important. Thirteen miles south of San Francisco, the lake is divided into two sections by an earth fill dam built in 1877.

The famous Crystal Springs Dam on San Mateo Creek, built on the east side of the lake, is one of the Water Department's showpieces. It was completed in 1890. A masterpiece of interlocking concrete block construction, the dam is a memorial to the skill of Spring Valley's Chief Engineer Schussler. It was designated a California Historic Civil Engineering Landmark by the American Society of Civil Engineers as part of its 1976 bicentennial activities.

Built 154 feet high, 176 feet thick at the base, and 600 feet long at the crest, Crystal Springs Dam sustained no trace of damage during the 1906 earthquake, even

Crystal Springs Dam, with a view to the northwest across the lake, was completed in 1890. The San Francisco Section of the American Society of Civil Engineers designated it a California Historical Engineering Landmark during the 1976 Bi-centennial. Designed by Spring Valley Water Company Chief Engineer Herman Schussler, it was the first dam built where the concrete mix was detailed. The cement was shipped around Cape Horn from Belgium in barrels.

though the San Andreas Fault is only 400 feet to the west. During its 88 years many homes, businesses, and institutions have been built in the shadow of the dam; and its existence has been the source of some uneasiness. Too bad those who worry could not have known about Herman Schussler.

The Water Department retained the consulting firm of W.A. Wahler and Associates to investigate and report on the safety of the dam. Wahler was responsible for the geologic aspects of the study. Associated firms — Lindvall, Richter and Associates and Group 10 Systems — were responsible for the seismological aspects and the structural analysis. Throughout the investigation close liaison was maintained with the State Division of Safety of Dams. The findings, announced in October, 1977, substantiate that this historic structure meets all of today's earthquake safety standards.

Completing Bay Division Pipeline No. 4

The final 8-mile link in the Water Department's fourth transbay pipeline — one of the two circling the south end of San Francisco Bay — was completed in 1973. This $5.5 million contract, awarded to the Hood Corporation, covered an area from Stanford University to the vicinity of Hassler Hospital on the Peninsula. Built of prestressed concrete with 9-inch walls, and an inside diameter of 84 inches, it increased the system's pipeline capacity for delivering water in the Peninsula lakes from 235 million gallons daily to 307 million gallons.

Crystal Springs Dam, completed in 1890, was an engineering masterpiece then (more so now). These photos show workmen digging material for concrete mix from a stone quarry three-fifths of a mile from dam site in 1887; placement of interlocking concrete blocks with an average volume of 350 cubic yards each (1888); and a photo made June 29, 1896, during a visit by members of the American Society of Civil Engineers.

Crystal Springs Bypass Tunnel

The ability to deliver Hetch Hetchy water directly into San Francisco, without storing it in Crystal Springs, was a long-term dream of the Water Department. The dream came true in 1968 with completion of the 3.25-mile Crystal Springs Bypass Tunnel and its .85-mile, 7.5-foot connector to existing Crystal Springs pipelines.

The 9-foot, concrete-lined tunnel was constructed by the joint venture contractors, Gates and Fox and Ball and Granite, at a cost of $8.6 million.

Using an ingenious 13-foot "mole", the builders drove a shaft from a point 2,000 feet east of Pulgas Temple on the Hetch Hetchy Aqueduct to a point a half-mile north of the Parrott Drive-Polhemus Road juncture in Hillsborough.

Final project in the program to bring Sierra water directly to San Francisco and north Peninsula users was construction of the underground Crystal Springs Balancing Reservoir along Canada Road, near Pulgas Water Temple.

The 60-million gallon covered reservoir and its related pumping station were built by Stolte, Inc. in 1975 at a cost of $4.6 million. Landscaping shields the huge concrete-lined structure from public view. Depending upon demand, the Water Department may build a twin to the reservoir immediately south.

Three deer from San Francisco's Crystal Springs watershed wander out of the trees to look things over on the Crystal Springs Golf Course. The 23,000-acre watershed is the only combination State Fish and Game Refuge in California.

Suburban Headquarters

The old complex of buildings at 1000 El Camino Real in Millbrae must give way to a new $3.2 million Suburban Headquarters serving the Alameda and Peninsula systems.

Most critical need for the new structure was replacement of the laboratory of the Water Quality Division, which was hard pressed to meet increasingly rigid Federal and State quality standards.

Most of the old buildings once belonged to the Spring Valley Water Company, some moved in from construction sites and others built on the spot.

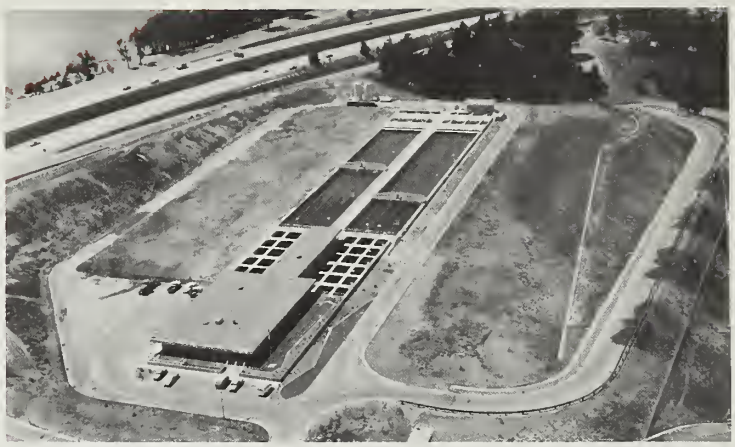
City Distribution Division

Five Peninsula transmission mains deliver water to four terminal distribution reservoirs and one large booster pump station within the City. A total of 18 distribution reservoirs, smaller storage tanks and eight hydropneumatic pumping stations serve City consumers through more than 1,150 miles of distribution lines.

San Francisco's hills, ranging in elevations from sea level to 900 feet, have created difficult supply problems for the engineers. They met the challenge by establishing 23 different "pressure districts".

Distribution reservoirs are in service at elevations ranging from 135 to 800 feet. Storage tanks are strategically located at elevations from 370 to 900 feet to serve — with the aid of hydropneumatic pump stations — small isolated sections of San Francisco. These storage facilities will hold 415 million gallons of water, about a 4.5-day supply. All major reservoirs have been covered and rehabilitated during the last 15 years.

The City Distribution Division operates and maintains 1,179 miles of transmission and distribution mains, with deliveries metered by 163,000 meters. Under a replacement program initiated in 1960, the Water Department has replaced 83,600 meters at the rate of over 5,000 a year.



The San Andreas Filtration Plant, near San Andreas Lake and west of Millbrae, went into service in 1972.

Water Quality

Throughout the history of the Water Department its supply has never been the cause of a waterborne disease. Its watersheds are either owned in fee or are protected and patrolled. Transmission facilities are virtually inviolate. Policies are unyielding to any activity that might threaten the quality of the water supply. Its Water Quality Division is staffed by skilled professionals who are highly respected throughout the water industry.

The Division's own goals are high, as they must be to meet increasingly rigid safeguards prescribed by the State and Federal governments. Its laboratory, maintained at the Suburban Headquarters in Millbrae, exercises control over the quality and treatment of water — subject to regular monitoring by the State Health Department. The staff is welcoming the use of modern facilities in Millbrae with construction of a new Suburban Headquarters.

Two modern filtration plants are now serving the Water Department under the supervision of the Water Quality Division.

The Sunol Valley Filtration Plant is located at the southern end of Sunol Valley in Alameda County. This plant treats water from the Calaveras and San Antonio Reservoirs. Completed in 1966 and expanded in 1976, it has a maximum capacity of 160 million gallons daily, double the capacity of the original plant. Its total cost was $10.5 million.

The San Andreas Filtration Plant, located adjacent to San Andreas Lake west of Millbrae, was completed in 1972 at a cost of $7.6 million. The normal capacity of the plant is 40 million gallons daily, and it has a peak capacity of double that amount.

The Division's sampling and testing responsibilities are systemwide — from Hetch Hetchy's highest sources to the distribution system in the City. Under Harry W. Tracy, Chief of the Division, its personnel operate a number of turbidity control, lime treatment, fluoridation, and chlorination stations.

About 39 pounds of lime are added to each million gallons of water at the Rock River plant located along Foothill Tunnel about a mile east of Oakdale. This raises the "pH" of the water, adding a small amount of hardness — reducing the slight acidity of the "too soft" Sierra water. (The pH scale has values running from 0 to 14 — pH 7 is neutral, below 7 acid, and above 7 alkaline or base). The treatment prevents corrosion of the aqueduct — as well as the household hot water tank.

Lime treatment can also take place at the filtration plants, along with chemical feeding equipment to remove turbidity and to provide complete disinfection.

Following voter approval of a policy declaration on the November, 1951, ballot favoring fluoridation, water served to consumers north of Crystal Springs and in San Francisco has been fluoridated — and tooth decay among children significantly arrested.

Conservation

In 1976 and 1977 the State of California and many other west coast regions sustained a disastrous drought — a record drought resulting from two back-to-back dry years. Although the impact was severe and left wounds that were hard to heal, Hetch Hetchy and the Water Department emerged from the ordeal with a supply of 132.36 billion gallons of water — 45 percent of storage capacity. Having this supply on hand after maintaining service for 1.8 million water users through two years of drought was another of many tributes to the planners and builders of Hetch Hetchy, and to persistent San Franciscans who won their fight for a municipally owned system.

The Public Utilities Commission adopted a water rationing program March 22, 1977, that became a pattern for other California cities. Terminating January 24, 1978, it exceeded the 25 percent savings goal, achieving instead an average 35 percent reduction in water consumption below 1976, the last previous "normal" year.

From the drought and rationing came a water conservation ethic that the Public Utilities Commission was quick to take advantage of. A permanent 15 percent voluntary reduction in water use was recommended to Water Department customers. This goal was exceeded when the reduction in consumption settled at 20 percent at the end of the year following the end of rationing. Post-rationing average daily consumption throughout the system at this time was 196 million gallons, about the same water use level of the 1963-64 fiscal year. Estimates for the 1979-80 fiscal year were for a 15 percent reduction in water use.

The Water Department explained to users they could attain this commendable conservation objective merely by avoiding waste, without denying themselves reasonable water requirements. Continued success of the voluntary conservation program, the Department added, would probably yield another dividend — delaying the need for costly capital improvements to increase water deliveries.

Preservation

Preservation is a way of life for the water industry. A ruined environment will not produce water.

Hetch Hetchy and the Water Department will stop at nothing to maintain the integrity of their water producing regions. They insist that they never moved into an area that failed to benefit by their presence. They need no illustrated lectures on the subject of preservation. It is part of their consciousness.

Hetch Hetchy people will remind those still willing to continue the Sierra dispute that other uses were in mind for the Hetch Hetchy Valley at the beginning of the century. One proposal to turn the valley into a summer resort to rival Yosemite Valley actually got under way in 1903-1904, but it failed in less than a year.

Congressman Francis Burton Harrison, protesting San Francisco's Hetch Hetchy plan, wrote the Interior Department on December 12, 1913:

"The Hetch Hetchy Valley is the only large level place in the northwestern portion of the park where hotels and permanent camps can be located."

In 1967 the Public Utilities Commission invoked a new Federal law to win an acceptable route (from a water supply point of view) for the Junipero Serra Freeway then under construction. The U.S. Department of the Interior, with a voice in the use of Federal highway assistance funds, rejected the State's plan to locate a 4.2-mile section of the freeway in the southern portion of the San Mateo watershed along the shore of Crystal Springs Lake. The State was forced to relocate the route near the crest of the east ridge; and the parties to the dispute eventually signed easement agreements that would keep the watershed inviolate forevermore.

The documents became effective in January, 1969, with Interior Secretary Stewart L. Udall's signature. Other signators were the City and County of San Francisco, the State of California, and San Mateo County.

By easement terms the 19,000 acres covering Crystal Springs Lakes and San Andreas Lake and watershed lands to the

west were declared a wilderness area to be held in perpetuity as an ecological preserve, dedicated to water supply use only, and accessible only by Water Department permit. The 4,000 acres in the southeast section between the lakes and the eastern boundary of the watershed were covered by a scenic and recreation easement.

As the San Mateo watershed lands are an island of wilderness in an area becoming more and more metropolitan, Water Department properties in the East Bay have played a major role in retaining places of beauty there.

The lovely Sunol Valley in Alameda owes its charm to the fact that its 24,267 acres are devoted to the San Francisco Water Department's system. Zealously protected by Alameda County planners, it has become a place of refuge for lovers of open space.

Epilogue

Most of us search for heroes as we move along through life. We need reassurance and inspiration in times of stress. It is comforting to know that we have contributed things of value to make life easier for our children. And it is part of the old American dream to provide the evidence.

I found some of my heroes in Hetch Hetchy and the Water Department. Some are names from the past who simply could not endure seeing a great City with a doubtful water supply. Some are retired. Some are on the job today.

They built big things — dams to save water for people, to keep rivers flowing all year long instead of drying up in the summer. They built tunnels deep in the earth — even beneath mountains. They brought in water to make cities beautiful.

Today, when knowledge of San Francisco's fine water supply system is in too many cases limited to the water faucet, their job may well be more difficult. The glamor of the big building is over, and the task of getting enough money to take care of the system remains.

They are fiercely protected of what they have created, and they love the land. They plant trees and restore the landscape. This is the nature of their work.

— J.H.L.

San Francisco Water and Power

By

James H. Leonard

Assistant to the General Manager of Public Utilities

Acknowledgements

Updating the popular "San Francisco Water and Power" publication edited in 1967 by Ted Wurm, was a welcome assignment, but difficult for those of us who are inclined to be wordy when Hetch Hetchy is the subject. Updating? This must be an extension of Mr. Wurm's fine work.

We were fascinated by "The Project", and quickly became a captive of Hetch Hetchy.

While a news reporter we were in the Canyon Power Tunnel when Clancy O'Dell's crews were drilling. After joining the PUC we were on hand for completion of the Kirkwood Powerhouse, ground breaking for Moccasin Powerhouse, and construction of Don Pedro Dam. There was the thrill of seeing the Water Department's two new filtration plants go into operation. Watching the holing through of the Crystal Springs Bypass tunnel 300 feet below ground was something to remember.

All of this helps explain the depth of our appreciation to those who have assisted in the preparation of this publication.

One of today's most qualified authorities on the history of Hetch Hetchy, Mr. Wurm is the author of a fine book, "Hetch Hetchy and its Dam Railroad" (Howell-North Books, 1973). Title notwithstanding, it covers the entire project, and it should be in every San Franciscan's library. References have been taken from both this book and Mr. Wurm's 1967 booklet. Other sources include:

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Hetch Hetchy Water Supply and Power Project, by M.M. O'Shaughnessy.

Annual Reports of the Bureau of Engineering of the San Francisco Department of Public Works, 1908-1931.

Annual Reports of the Hetch Hetchy system.

Annual Reports of the San Francisco Water Department.

Annual Reports and documents of the San Francisco Public Utilities Commission.

The Oakland Museum.

Newspaper accounts — Modesto Bee, San Francisco Call, San Francisco Call Bulletin, San Francisco Chronicle, San Francisco Examiner.

Mill Valley Public Library.

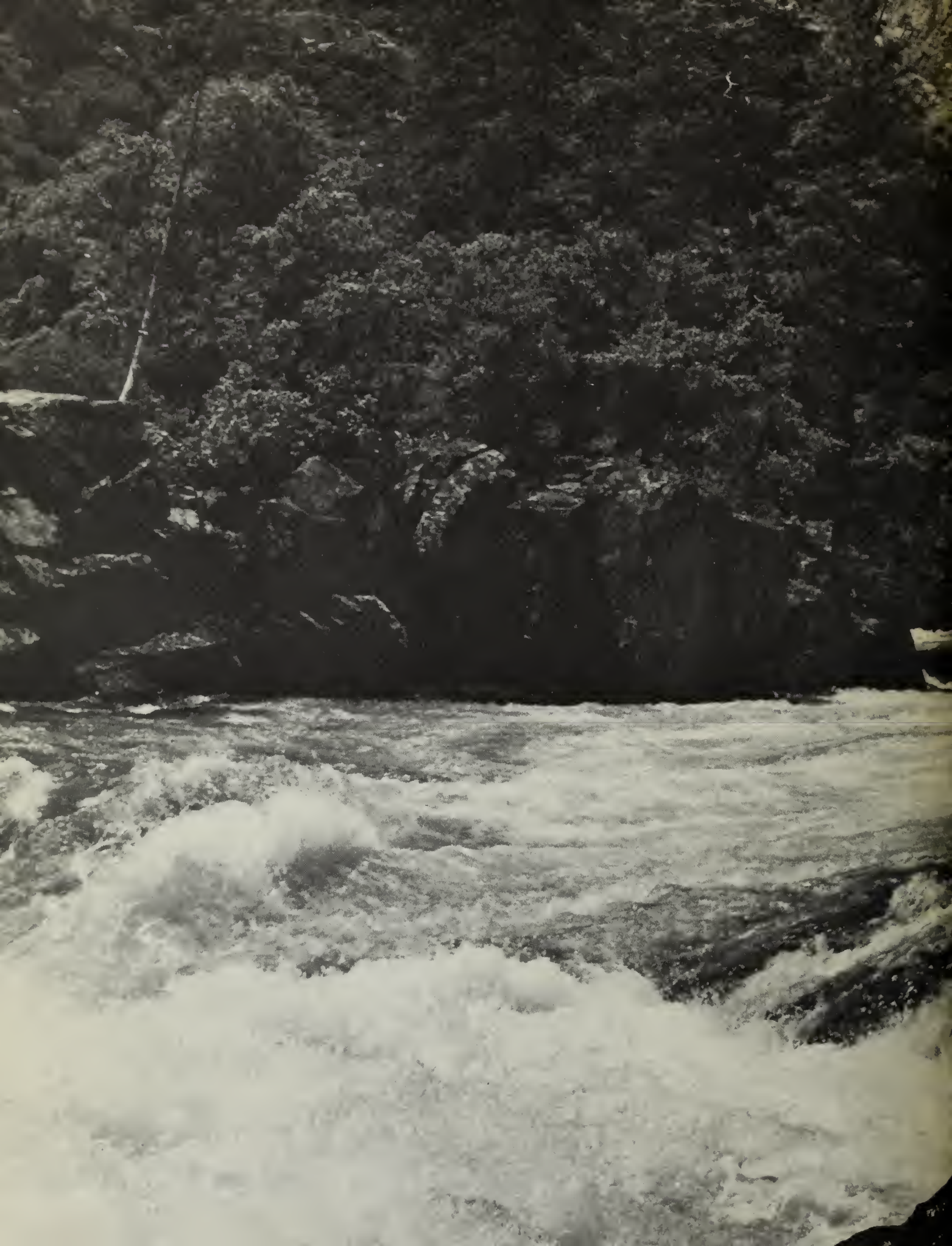
The Yosemite, by John Muir.

Hetch Hetchy, by R.W. Taylor.

In addition to Oral L. Moore other helpful individuals were: Eugene J. Kelleher, General Manager and Chief Engineer, S.F. Water Department; Edward L. Fonseca, Assistant Manager, Suburban Division, Water Department; Gladys Hansen, Archivist of the San Francisco Public Library; and Wesley F. Getts, now retired, former Principal Engineer for Hetch Hetchy. Photos are from Public Utilities Commission files. Many of them were made by Marshall Moxom, who retired in 1978 after 32 years as the Commission's Head Photographer.

San Francisco Water Department
General Managers — Chief Engineers

[illegible]	1930-1948
[illegible]	1949-1957
[illegible]	1957-1963
[illegible] (Acting)	1963-1965
H. Christopher Mackbery (acting)	1963-1965
[illegible]	1965-1976
[illegible]	1976-1978
[illegible]	1978

Water Department's Senior Staff

[illegible]	Eugene J. Kelleher
[illegible]	Cyril J. Roche
[illegible]	Paul Matsumura
[illegible]	Thomas Q. Chan
[illegible]	Donald P. Cooper
[illegible]	Raymond F. Quan
[illegible]	John E. Kenck
[illegible]	George Y. Nakagaki
[illegible]	Edmund A. Brodie
[illegible]	Gilbert G. Bendix
[illegible]	Edward L. Fonseca
[illegible]	Tandy W. Carter
[illegible]	Harry W. Tracy
[illegible]	John Mullane
[illegible]	Dorothy J. Disney
[illegible]	Harold Guetersloh Jr.
[illegible]	Richard Tanaka